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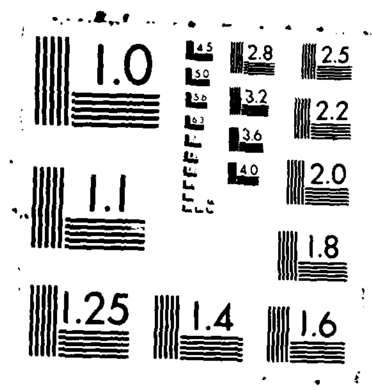
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PEAK POWER COST REDUCTION GUIDEBOOK

M.K. SELCUK & W.A. EDMISTON
JET PROPULSION LAB
CALIFORNIA INSTITUTE OF TECHNOLOGY
PASADENA, CALIFORNIA 91109

DECEMBER 1985

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The report is organized as a guidebook with worksheets for the estimation of energy savings, power savings, and dollar savings to be gained through the implementation of techniques to reduce peak power demand. Interconnection, energy management and control systems, and on-site generation are the techniques considered.

PREFACE

This report documents work performed by the Jet Propulsion Laboratory (JPL), California Institute of Technology, Pasadena, California 91109, under Project Order No. F-83-36 with the Air Force Engineering and Services Center, Tyndall AFB, Florida 32403-6001 and through NASA (NASA Task RE-152, Amendment 364). Major Dwight Odom was the project officer for the Air Force Engineering and Services Center. This technical report has been reviewed and is approved for publication.

The purpose of this report is to present a methodology for the evaluation of techniques for reducing peak power demand and costs by Air Force base civil engineers. The report is organized as a guidebook with worksheets for the estimation of energy savings, power savings, and dollar savings to be gained through the implementation of techniques to reduce peak power demand. Interconnection, energy management and control systems (EMCS), and on-site generation are the techniques considered.

This report has been reviewed by the Public Affairs Office (PA) and is releasable to the National Technical Information Service (NTIS). At NTIS it will be available to the general public, including foreign nationals.

This technical report has been reviewed and is approved for publication.

Freddie L. Beason, P.E.
Mechanical Engineer/Energy

Robert L. Smith, Jr.
Major, USAF
Chief, Energy Division

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SECTION I

INTRODUCTION

A. PURPOSE

This guidebook was developed to assist Air Force base civil engineering staff in evaluating alternative methods for reducing the electric utility costs at the base. The guidebook uses a series of worksheets that are designed to evaluate the electricity consumption patterns at the base, determine the potential cost savings due to peak shaving, and evaluate alternative methods for achieving cost savings.

Most Air Force bases are major daytime users of electric power, with very high on-peak electric power demands. Electric utilities charge their customers not only for the amount of electric energy consumed, measured in kilowatt-hours (kWh), but also for the peak power demanded, measured in kilowatts (kW). Each utility has its own policy for determining the rates to charge its customers, but the cost of on-peak power is high and increasing. Consequently, there is a potential for dollar savings if the peak power demanded from the utility can be reduced by changing or shifting consumption patterns. This is often referred to as peak shaving.

Most electric utilities define different types of rate structures for different types of customers, summarized in the form of rate schedules, that take into account both the quantity of electricity purchased and the peak demand, as well as the time of day the electricity is demanded. This is especially true of sales to industrial customers, such as Air Force bases. Thus, by finding ways to reduce the peak power demand from the utility, an Air Force base may be able to achieve dollar savings.

B. COST REDUCTION METHODS

The methods for reducing electric utility costs vary widely, from conservation to energy storage, and may be classified into six groups.

1. Conservation

Conservation reduces the energy consumed and may reduce the peak demand. Any procedure that reduces electrical consumption, especially during the peak time of day, is applicable. Conservation usually includes "housekeeping" measures, such as turning off lights, setting thermostats higher in summer and lower in winter, etc. In general, conservation reduces costs through reduced consumption and should be the first method pursued for achieving cost reduction because it requires no capital investment and no additional operation and maintenance (O&M). Conservation should be implemented before using this guidebook.

2. Rescheduling

Rescheduling, or time-of-day shifting, reduces the peak demand without reducing the energy consumed, that is, without conservation. An example is rescheduling an operation from the day shift to the night shift, thus reducing the peak load during the day and shifting it to the night when there is less demand. If the base mission does not preclude the rescheduling of an operation, this should also be one of the first methods pursued because of the probable cost savings due to lower off-peak rates. This method also involves no capital investment and generally no additional O&M (nighttime wage differential excluded) and should be implemented before using this guidebook.

3. Fixed Charge Minimization

Minimizing the fixed charges will reduce the utility bill without reducing either the peak demand or the energy consumed. This may be accomplished by reducing charges or increasing credits that are not associated with the actual electricity demand or consumption. For example, a utility may apply a fixed service charge for the hookup to the electric meter. If more than one meter is used to serve the base, the service charge would be proportionally greater.

In this case, interconnection to one meter can reduce the monthly service charges. There is no additional O&M required, but there may be a one-time charge by the utility to achieve the interconnection, and the monthly savings should be evaluated against that charge. Interconnection is one of the alternatives examined in this guidebook.

4. Energy Management and Control System

The utilization of energy management and control systems (EMCSs) usually results in improved energy efficiency in operations. In most instances, an EMCS can reduce both demand and consumption, as well as perform a variety of energy management functions that reduce costs. The use of an EMCS is a form of conservation but is listed separately because it requires a capital investment and additional O&M. The installation of an EMCS is the second alternative examined in this guidebook.

5. On-Site Generation

On-site power generation reduces the peak demand and the energy purchased from the utility without necessarily reducing the peak power to the base or the total amount of energy consumed. Emergency power generation facilities, a dedicated on-site power plant, or a cogeneration facility can be used for on-site power generation. This method depends on the capability of the base to generate electricity less expensively than the utility's peak charge. This method of peak shaving is the third alternative examined in this guidebook.

6. Energy Storage

Energy storage is the most complex method; it reduces the peak demand while the energy consumed increases. Energy is stored at night, during which time the demand is low and energy charges are at lower, off-peak rates. The stored energy is then used during the day when the demand is high. Due to losses that occur through the charge-storage-discharge process, the total energy consumption, in kWh, is usually about 25% higher than direct use. Such a system could only be beneficial in cases where substantial off-peak rate savings are offered. Energy storage, in general, applies to large industrial/commercial facilities, and its application is often limited by high initial capital requirements. This option is not examined in this guidebook.

C. USE OF GUIDEBOOK

In this guidebook, only a general methodology of system evaluation and indications on cost is given. The users of the guidebook are urged to obtain firm quotations from vendors or contract studies for the final evaluation of complicated systems.

The logic of selecting a system to reduce the electricity cost is based on estimating the total project life-cycle cost based on assumed values for the savings-to-investment ratio (SIR) and discounted payback period (DPB). This estimated cost is then compared to the cost of the alternative techniques to determine which is best suited to the base's energy needs.

Before proceeding to the technical solutions described in this guidebook, which require a capital investment, options such as conservation and rescheduling must be fully explored. The energy usage at the base should be categorized as (1) environmentally affected loads, such as heating and cooling; (2) service related loads, such as workshops, laundries, paint shops, etc.; and (3) mission-related loads, such as radars, computers, runway lights, etc. Usually, mission-related loads cannot be significantly reduced, but loads under the first and second categories should be examined to see whether a change in the operating schedule might reduce these loads.

Worksheet A, Site and Load Data, is designed to assist in collecting and organizing the base energy consumption data for analysis. Early start and finish of work during summer periods would reduce the peak demand caused by air-conditioner usage during late afternoon periods. If shifting to a night schedule is possible, the increased usage of light should be traded off with the decreased air-conditioning load. The impact of rescheduling the operation may be examined by comparing the on-peak demand and expenses with the shifted off-peak demand and related expenses.

The next step is to calculate and plot the base's load profile using Worksheet B, Load Profile, to determine the daily pattern of consumption and to determine the nature, extent, and occurrence of the peak demand.

The rate structure of the utility serving the base is analyzed next in Worksheet C, Components of a Utility Bill. This allows the base civil engineer to disaggregate energy, power, and other charges. Also, time-of-day, day-of-week, and quantity discounts or surcharges may be analyzed.

After understanding the base load profile and the utility rate structure, it is possible to estimate the potential cost savings that could result from shaving the peak; this is quantified in Worksheet D, Prediction of Potential Cost Savings.

In a few cases it may be that either the base does not have a noticeable peak, and/or the utility rate structure does not penalize the occurrence of peak usage. In these cases potential cost savings would be minimal.

The final step is to examine the three candidate methods to determine which is a viable, cost-saving technique. Worksheet E, Economic Feasibility Evaluation, evaluates the economic viability of the three methods: Interconnection, EMCS, and On-Site Generation. The latter is divided into a choice between generating electricity for direct use at the base and generating heat and electricity for use at the base as well as selling some back to the utility.

SECTION II

SITE AND LOAD DATA: WORKSHEET A

The first step of the analysis requires the collection of site-specific data for the entire base or site. Worksheet A is arranged to help serve this purpose. Entries A1 through A9 are informational and not used in the actual analysis; therefore, collection of these data can be omitted. However, entries A10 through A15, the site and load data, are needed to determine the range of the demand and consumption on an annual basis. For this analysis, the highest demand month will be used first because if there is no promise of reducing the utility bill through peak shaving for the highest month, then there is no need for further analysis. If the highest demand month does show promise for cost savings, then other months should also be examined to determine a better indication of the potential cost savings.

The entries are a condensed guide to the site-specific base characteristics that will be helpful later. The user may want to tailor the worksheet into more specific groupings to fit the characteristics of the base under consideration. Most bases will probably have available detailed engineering plans, drawings, layouts, etc. Initially, it is only necessary to collect what is available without expending a great deal of effort. Later, if it happens that the base under consideration has a high potential for cost savings by peak shaving, these data may then be analyzed in more detail. For example, to evaluate an energy management and control system prior to a decision to implement, it is necessary either to have detailed facility data or to conduct a survey to obtain the information.

WORKSHEET A

A1.	Enter the name of the base.	A1	____________
A2.	Enter the location of the base.	A2	____________
A3.	Enter the electrical utility (or utilities) serving the base.	A3	____________
A4.	Enter the number of electric meters serving the base.	A4	____________
A5.	Enter the on-site electrical generation capacity, if any.	A5	____________
A6.	Enter the site population.		
	a. Military	A6a	____________
	b. Civilian	A6b	____________
A7.	Enter the facilities on the base.		
	a. Number	A7a	____________
	b. Total area (ft^2)	A7b	____________
A8.	Enter the buildings on the base.		
	a. Number	A8a	____________
	b. Total area (ft^2)	A8b	____________
A9.	Enter the housing units on the base.		
	a. Number of single-family units	A9a	____________
	b. Number of multiple-family units	A9b	____________
	c. Total area (ft^2)	A9c	____________
A10.	Fill in Table A-1 with the monthly demand and consumption data obtained from the utility bills.	A10	Table A-1
A11.	Enter the peak demand; it is the highest value entered in the Demand column of Table A-1.	A11	____________
A12.	Enter the peak demand month.	A12	____________
A13.	Enter the high month energy consumption; it is the highest value entered in the Energy column of Table A-1.	A13	____________
A14.	Enter the sum of the monthly peak demand values by adding the data in the Demand column of Table A-1.	A14	____________
A15.	Enter the total annual energy consumption by adding the data in the Energy column of Table A-1.	A15	____________

WORKSHEET A (continued)

Table A-1. Demand and Consumption

Month	Demand (kW Peak)	Energy (kWh)
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		
Total		

END OF WORKSHEET A

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SECTION III

LOAD PROFILE: WORKSHEET B

The load profile is the variation in the power demanded over a period of time. Analysis of the load profile will yield the information needed to determine the potential for peak shaving.

To develop the load profile for the base, load data for the highest demand month is needed. The load data comprising the 24-hour variation of the electricity demand for two average workdays and one normal weekend day during the month is needed. The selected days should be typical for the month to ensure that the data are reasonably representative of the month's demand.

A utility will generally provide these load data upon request. Hourly data are adequate for this analysis; if 15-minute interval data are provided, calculate the hourly average. In the absence of utility-provided data, meter readings taken on an hourly basis can be used to generate the load data. This can be accomplished by taking a reading once an hour for the representative 24-hour periods. If there is more than one meter for the base, each meter must be read and the results summed for each hour.

Next, the tabulated load data is converted to a percentage tabulation that will be used to develop the load profile curve. The load profile curve is a plot of the power demanded versus the time of day. A typical load profile curve is illustrated in Figure 1.

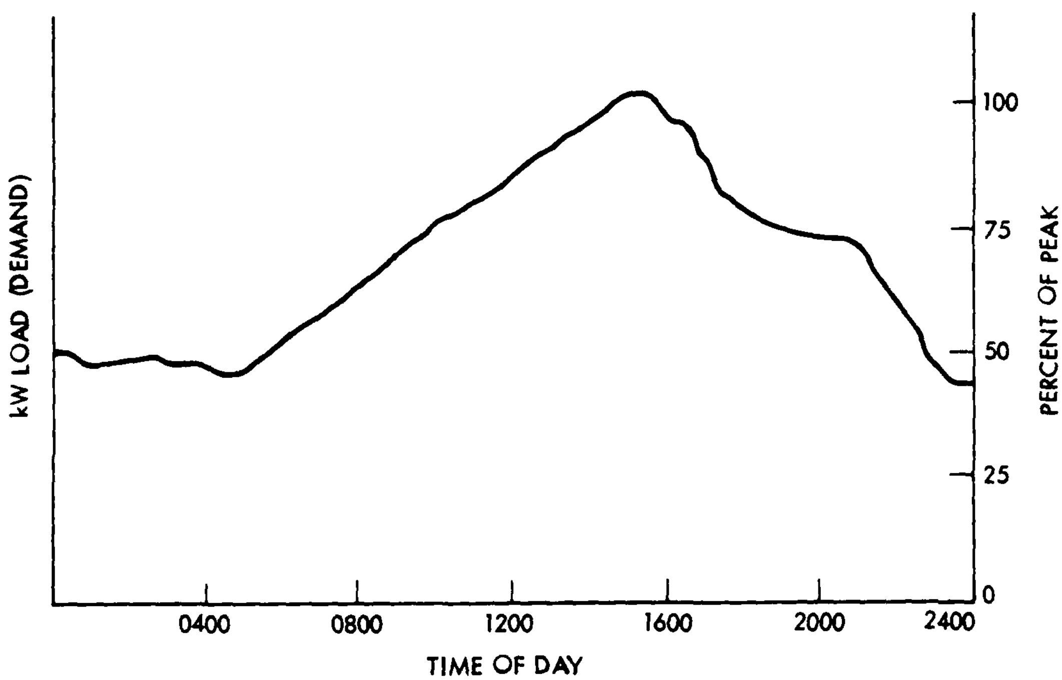

Figure 1. Typical Load Profile Curve

For analysis, the three load profiles must be simplified and converted to a generic load profile. The two weekday and one weekend day load profiles will be averaged and plotted to highlight three distinct time periods with flat load levels. The resulting graph is referred to as the generic load profile.

The generic load profile is a simplified straight line curve of the percent of peak load corresponding to a time period under study for the base. Thus, the generic profile will represent the 24-hour variation of the load for the month selected for study. The shape of the generic load profile is based on a study by Science Applications, Inc. (SAI) (Reference 1) and supporting analysis to this report.

A generic load profile is assumed to have three flat load levels that are joined by straight lines as illustrated in Figure 2.

These flat levels, denoted A, B, and C, represent the three periods, late night, day peak, and evening. The actual time periods associated with the three load levels may vary for different sites and different times of the year, depending on the type of load and season. Generally, however, the time periods fall somewhere in the following ranges:

A: Late night period	0300 to 0600 hours
B: Day peak period	1200 to 1600 hours
C: Evening period	1900 to 2200 hours

Generally, the late night period, A, has the lowest demand. During summer months and working days, the highest values are during the day peak period, B, i.e., 100% on the generic load profile scale. The evening period, C, represents the mid-peak or medium demand. As an exception, the evening period demand may be close to

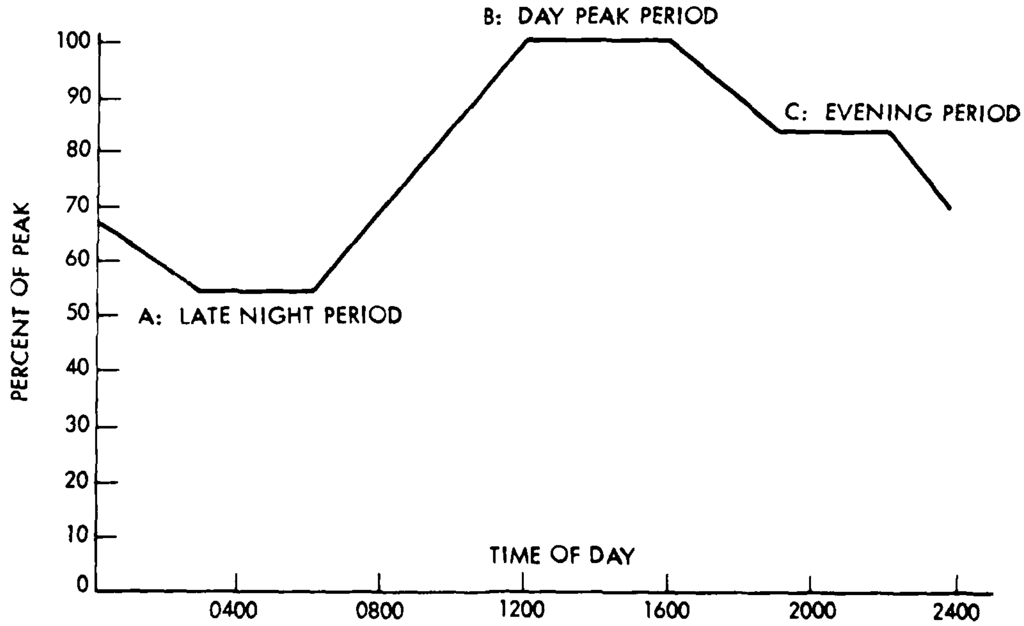

Figure 2. Generic Load Profile Curve Using Default Values

the day peak demand, and even exceed it for weekends or at sites with very cold climates during the winter months. In that case, the evening period, C, would be 100% or very close to it.

To develop the generic load profile, the load profile percent of peak data for the three typical 24-hour days, is averaged and plotted. If these data are not available, an alternative using default values, discussed below, can be used.

For each day for which data have been gathered, the three-hour period that best represents each of the three flat load levels should be determined. This is done by observing the data in the intervals defined for each period. For the late night period (A) and the evening period (C), obtain the average load percentage for each period by summing the hourly percent of peak data for the time period and dividing by three. The average load percentage for the day peak period (B) is 100%.

The monthly average value for each time period is obtained by adding the three values for the time period and dividing by three.

The resulting generic load profile is then plotted. This is done by drawing horizontal lines for the flat time periods (A, B, and C) and then connecting the end points. Figure 2 is an example of a generic load profile using the default values discussed below.

For those sites having more than one meter connection, the generic load profile should be determined for the sum of each meter's data.

In the event that the actual load data cannot be obtained, default values for A, B, and C can be used; these are as follows: A = 55%, B = 100%, and C = 85%. These A, B, and C values are based on the SAI study (Reference 1) and analysis done in support of this report. Default results are considered accurate to within ± 10%. A screening analysis based on default values should be confirmed later by actual data prior to any significant capital investment.

To accomplish savings due to peak shaving, the load profile must demonstrate a noticeable peak in demand that is at least 10% higher than the mid-peak value, i.e., B should be at least 10% larger than C. If a sizable peak does not occur, cost reduction potential through peak shaving is negligible. If that is the case, further study is unnecessary. If there is a sizable peak occurring, cost reduction potential should be examined further, repeating the process for additional months.

The generic load profile analysis is applicable for most of the continental United States. Unusual cases, such as extremely high-latitude, cold-climate sites or bases with primarily night operations, may not follow this pattern. It should also be noted that for those sites with little difference between the day peak (B) and evening peak (C) values and/or for those bases served by a utility that does not charge for the peak kW demanded, peak shaving will not reduce the utility bill and this analysis does not apply.

WORKSHEET B

B1. Fill in the Demand column of Table B-1 using hourly load data for two average workdays and one normal weekend day obtained from the utility. If 15-minute interval data are provided, calculate the hourly average. Sum each of the three Demand columns and enter the total. — B1 Table B-1

B2. Calculate the average of the three Demand column totals from Table B-1. — B2 ________

B3. Calculate the percent of peak demand. For each hour's entry in the Demand column, divide by the highest value for that day in the same column and enter the result in the adjacent column, % of Peak. — B3 Table B-1

B4. Determine the three-hour period that best represents the late night, flat load level period, A. (Look in Table B-1 around the period from 0300 to 0600 for four entries that are about the same percent.) — B4 ________

B5. Determine the three-hour period that best represents the day peak, flat load level period, B. (Look in Table B-1 around the period from 1200 to 1600 for four entries that are about the same percent.) — B5 ________

B6. Determine the three-hour period that best represents the evening, flat load level period, C. (Look in Table B-1 around the period from 1900 to 2200 for four entries that are about the same percent.) — B6 ________

B7. Determine the average percentage load for the A and C flat load periods for each day; the average percentage load period B is 100%. Fill in Table B-2. — B7 Table B-2

B8. Determine the month's average percentage load for the three flat load periods and enter in Table B-2. If these data are not available, use the following default values for the three flat load periods: — B8 Table B-2

A:	Late night period	55%
B:	Day peak period	100%
C:	Evening period	85%

B9. Plot the generic load profile onto Figure B-1 using the month's average data in Table B-2. — B9 Figure B-1

WORKSHEET B (continued)

Table B-1. Load Profile Hourly Data

	Weekday #1 Date: _______		Weekday #2 Date: _______		Weekend Day Date: _______	
Hour	Demand (kW)	% of Peak	Demand (kW)	% of Peak	Demand (kW)	% of Peak
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500						
1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
2400						
Total		----		----		----

WORKSHEET B (continued)

Table B-2. Average Percentage Load for Flat Load Level Periods

Date	A: Late Night	B: Day Peak	C: Evening
Weekday #1		100	
Weekday #2		100	
Weekend day		100	
Default Values	55	100	85
Month's Average		100	

WORKSHEET B (continued)

Total Area = ____________

5% Area = ____________

10% Area = ____________

15% Area = ____________

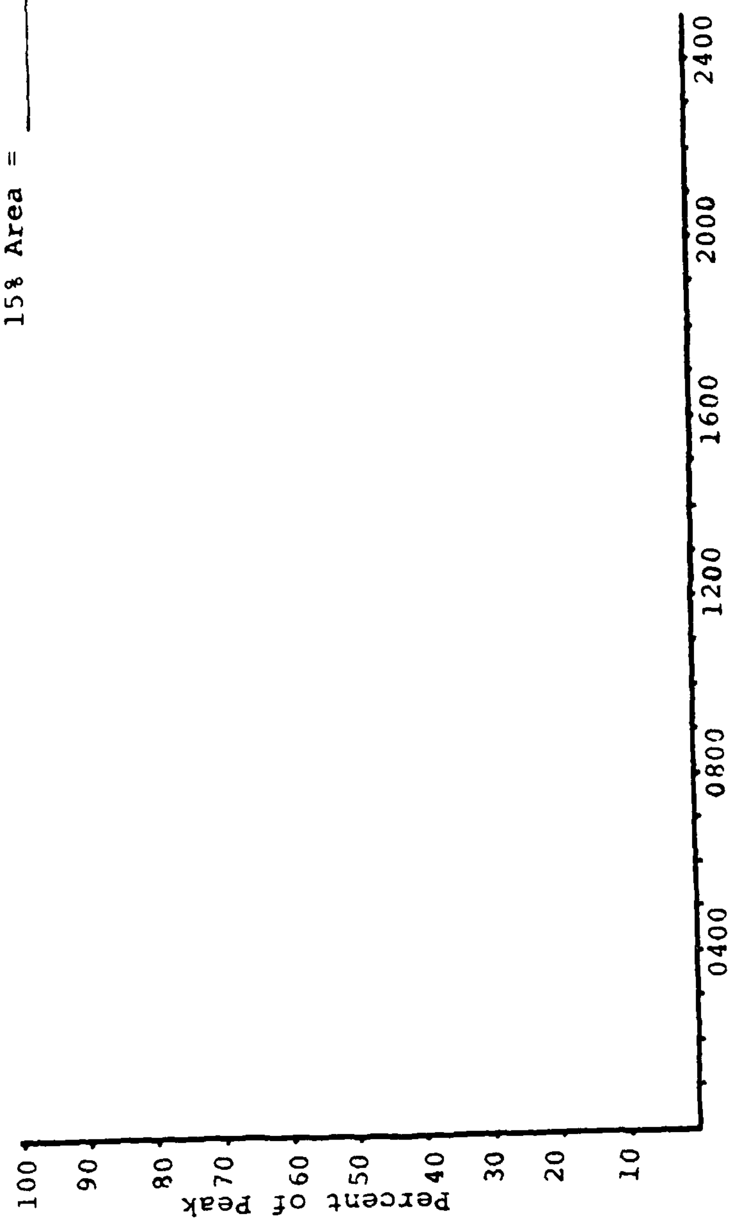

Figure B-1. Plot of the Generic Load Profile

END OF WORKSHEET B

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SECTION IV

COMPONENTS OF A UTILITY BILL: WORKSHEET C

The utility bill sent to customers is based on the applicable rate schedule and usually includes demand, energy, and other charges. There also may be time-of-day adjustments. Therefore, careful examination of the utility bill will provide the unit cost information needed to determine whether or not peak shaving will be financially successful.

Unlike residential bills, utility bills for large industrial-commercial users, such as Air Force bases, are quite complicated. Worksheet C was developed to provide an understanding of the utility rate structures for the base under study.

Worksheet C is arranged to analyze a utility bill that has on-peak, mid-peak, and off-peak rates. If there is a fixed rate per kWh for energy, then only one column needs to be filled. If there are no demand charges, or the rates decline with increasing demand and total energy consumption, then cost reduction through peak shaving is unlikely, and further analysis should focus on conservation.

Worksheet C identifies the key elements in the structure of a typical utility bill and illustrates how some surcharges as well as discounts are applied. The most significant discount offered by most utilities is for the use of off-peak energy. This implies that each kWh of energy consumed during off-peak hours costs less than the energy consumed during on-peak hours. The delineation of the off-peak hours is at the discretion of the utility. Generally, during summer months and daytime hours, rates are higher. Some utilities also have mid-peak rates, which are between the off-peak and on-peak rates.

Surcharges or credits may be related to the power demanded in kW or energy consumed in kWh. Examples of surcharges are fuel adjustment clauses, meter charges, and equipment rental, among others. Credits are often given for such things as installing transformers and adding equipment to correct the power factor. The utility bill usually contains information regarding the various rates and charges.

The data required for the entries on Worksheet C are obtained from the utility bill for the highest demand month, which was selected as the basis for analysis on Worksheet A. For initial screening, use of the data from the high month is adequate. Later, or before a final commitment to a peak shaving technology, it may be necessary to do each month separately and sum the results for annual figures, especially if the utility rate schedule exhibits seasonality (i.e., different rates in summer versus winter).

WORKSHEET C

C1.	Enter the peak power demand in the three utility-defined periods in Table C-1. (Either use the utility bill as the source for these data or request the data from the utility.)	C1 Table C-1
C2.	Enter the demand charge rates ($/kW) for on-peak, mid-peak, and off-peak demand for the different kW ranges indicated in Table C-1.	C2 Table C-1
C3.	Enter the actual demand charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total demand charges. (Use the utility bill as the source for these data.)	C3 Table C-1
C4.	Enter the energy consumed in the three utility-defined periods in Table C-1. (Use the utility bill as the source for these data.)	C4 Table C-1
C5.	Enter the energy charge rates ($/kWh) for on-peak, mid-peak, and off-peak energy consumption or for the different kWh ranges indicated in Table C-1.	C5 Table C-1
C6.	Enter the actual energy charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total energy charges. (Use the utility bill as the source for these data.)	C6 Table C-1
C7.	Enter the total for each entry in Table C-1 in the Total column.	C7 Table C-1
C8.	Enter the surcharges that are listed on the utility bill.	
	a. Fuel adjustment (__________ $/kWh)	C8a __________
	b. Customer charges	C8b __________
	c. Equipment rental	C8c __________
	d. R&D fund	C8d __________
	e. Other	C8e __________
	f. Total Surcharges (sum C8a through C8e)	C8f __________
C9.	Enter the credits that are listed on the utility bill.	
	a. Transformer	C9a __________
	b. Power factor adjustment	C9b __________
	c. Other	C9c __________
	d. Total Credits (sum C9a through C9c)	C9d __________

WORKSHEET C (continued)

C10. Enter the net additional charges. (C8f minus C9d) — C10 ________

C11. Enter the total actual payments (Total demand charges from Table C-1 + Total energy charges from Table C-1 + C10) — C11 ________

WORKSHEET C (continued)

Table C-1. Demand and Consumption Data

Utility Bill Entry	Time of Day			Total
	On-peak	Mid-peak	Off-peak	
Peak Power Demand (kW)				-----
Demand Charge Rates ($/kW)				
__0__ to _____ kW				-----
_____ to _____ kW				-----
_____ to _____ kW				-----
Demand Charges ($)				
0 to X kW				
X to Y kW				
Y to Z kW				
Total Demand Charges				
Energy Consumed (kWh)				
Energy Charge Rates ($/kWh)				
__0__ to _____ kWh				-----
_____ to _____ kWh				-----
_____ to _____ kWh				-----
Energy Charges ($)				
0 to X kWh				
X to Y kWh				
Y to Z kWh				
Total Energy Charges				

END OF WORKSHEET C

SECTION V

PREDICTION OF POTENTIAL COST SAVINGS: WORKSHEET D

Peak shaving is the process of reducing the peak power level demanded. A reduction in the amount of energy purchased from the utility may also occur. The reduction can be represented on the generic load profile curve. For example in Figure 3, a 5% reduction due to peak shaving is represented by the shaded area; the percentage reduction in energy purchased is the shaded area divided by the total area under the load profile curve. The total area under the curve is the summation over the 24-hour period of the kW demand times the duration of that demand; it represents the energy consumed. Thus, by using the case-specific generic load profile calculated and plotted in Worksheet B, the percentage reduction in energy purchased from the utility, referred to as the energy reduction factor, r, can be calculated for any given level of peak shaving.

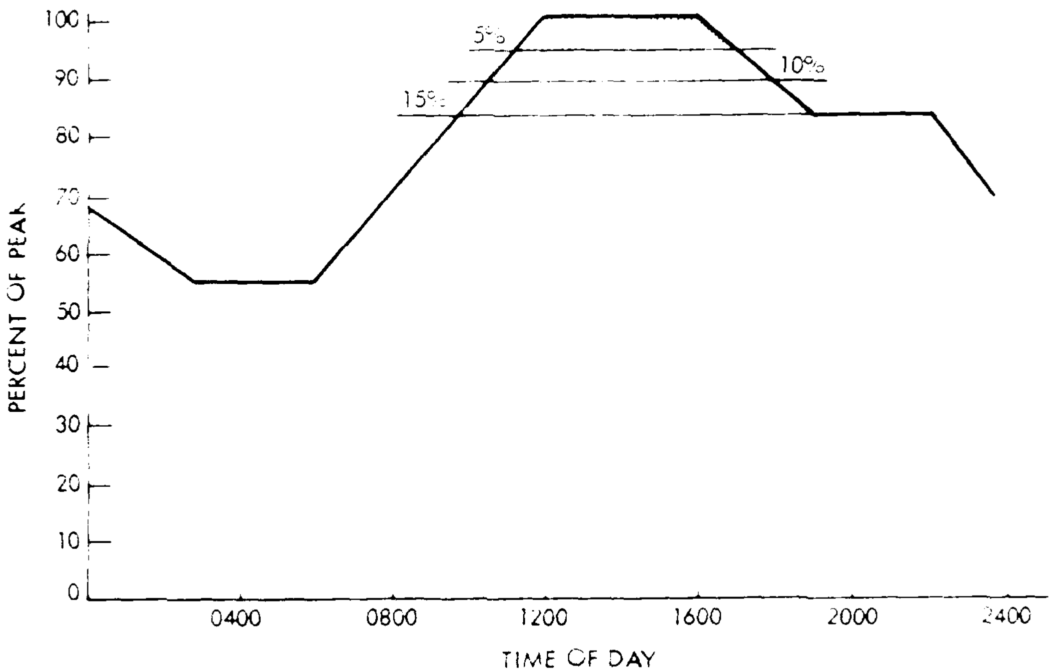

Figure 3. Peak Shaving Represented on the Generic Load Profile Curve

As an example, calculations have been made using the default values for A, B, and C from Worksheet B. For 5% peak shaving, the ratio of the reduction of the energy purchased to the daily total is about 0.013 or 1.3%. Similarly, calculations for 10% and 15% peak shavings yield r = 0.03 and r = 0.05, respectively. Peak shavings of over 15% are unlikely, but could be calculated in a similar manner.

In concert with the calculation of energy savings (when they occur) that correspond to a given peak shaving, it is possible to predict dollar savings for that level of peak shaving. For any given course of action that results in peak shaving, whether it involves the purchase and installation of capital equipment or the rescheduling of certain energy intensive activities, the dollar savings may be predicted.

Worksheet D presents a basic methodology for calculating energy savings and determining the dollar savings that correspond to a reduction of kW demanded and kWh energy consumed. The savings consist of the sum of changes in demand, energy, surcharges, and credits resulting from the peak shaving. Three alternative methods that are variations of the basic methodology, starting with a quick but simple screening and proceeding to a more accurate but tedious way of estimating the annual energy and demand cost savings, are presented for estimating the annual savings. The predicted savings are compared with the necessary investment to determine economic feasibility in the next section.

WORKSHEET D

Basic Methodology

D1. Mark the 5%, 10%, and 15% peak shaving levels on the generic load profile curve, Figure B-1 of Worksheet B. — D1 Figure B-1

D2. Calculate the energy reduction factor, r, corresponding to the 5%, 10%, and 15% peak shaving levels. Divide the area that represents the 5%, 10%, and 15% reduction levels by the total area under the generic load profile curve.

a. 5% energy reduction factor — D2a ______
b. 10% energy reduction factor — b ______
c. 15% energy reduction factor — c ______

If the default generic load profile curve was used for Figure B-1, enter the default values as follows:

for 5% reduction, r = 0.013
for 10% reduction, r = 0.03
for 15% reduction, r = 0.05

D3. Calculate the energy reduction for the month under analysis for each level of peak shaving.

a. for 5%, D2a x A13 — D3a ______
b. for 10%, D2b x A13 — D3b ______
c. for 15%, D2c x A13 — D3c ______

D4. Calculate the dollar savings due to the reduction of energy consumption. Use the highest C5 entry from Worksheet C, which is the energy rate in $/kWh. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D4 Table D-1

a. for 5%, D3a x C5
b. for 10%, D3b x C5
c. for 15%, D3c x C5

D5. Calculate the peak demand reduction for the 5%, 10%, and 15% reduction levels.

a. for 5%, A11 x 0.05 — D5a ______
b. for 10%, A11 x 0.10 — D5b ______
c. for 15%, A11 x 0.15 — D5c ______

D6. Calculate the dollar savings due to the reduction of peak demand. Use the highest C2 entry from Worksheet C, which is the demand rate in $/kW. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D6 Table D-1

a. for 5%, D5a x C2
b. for 10%, D5b x C2
c. for 15%, D5c x C2

WORKSHEET D (continued)

D7. Calculate the surcharge reduction, if applicable, and enter in Table D-1. For an energy-related surcharge (i.e, $/kWh), the dollar savings would be as follows: — D7 Table D-1

  a. for 5%, surcharge rate from C8 entry x D3a
  b. for 10%, surcharge rate from C8 entry x D3b
  c. for 15%, surcharge rate from C8 entry x D3c

For a demand-related surcharge (i.e., $/kW), the dollar savings would be as follows:

  d. for 5%, surcharge rate from C8 entry x D5a
  e. for 10%, surcharge rate from C8 entry x D5b
  f. for 15%, surcharge rate from C8 entry x D5c

D8. Calculate the credit increase, if applicable, and enter in Table D-1. For an energy-related credit (i.e., $/kWh), the dollar savings would be as follows: — D8 Table D-1

  a. for 5%, credit rate from C9 entry x D3a
  b. for 10%, credit rate from C9 entry x D3b
  c. for 15%, credit rate from C9 entry x D3c

For a demand-related credit (i.e., $/kW), the dollar savings would be as follows:

  a. for 5%, credit rate from C9 entry x D5a
  b. for 10%, credit rate from C9 entry x D5b
  c. for 15%, credit rate from C9 entry x D5c

D9. Determine the potential monthly dollar savings due to peak shaving by summing the data in Table D-1. — D9 Table D-1

Annual Savings - Approximate Method

This method will overstate the annual savings.

D10. To approximate the annual savings due to peak shaving, multiply the Monthly Dollar Savings by 12 in Table D-1. — D10 Table D-1

Annual Savings - Improved Method

D11. Do steps D3 through D8 of the basic methodology using A15 and A14 in place of A13 and A11, respectively.

Step D3:	D2a x A15	D11a ______
	D2b x A15	D11b ______
	D2c x A15	D11c ______
Step D4:	D11a x C5	D11d Table D-2
	D11b x C5	
	D11c x C5	

Step D5:	A14 x 0.05	D11e	________
	A14 x 0.10	D11f	________
	A14 x 0.15	D11g	________
Step D6:	D11e x C2	D11h	Table D-2
	D11f x C2		
	D11g x C2		
Step D7:	D11a x C8	D11i	Table D-2
	D11b x C8		
	D11c x C8		
Step D8:	D11e x C9	D11j	Table D-2
	D11f x C9		
	D11g x C9		

D12. Determine the potential annual dollar savings due to peak shaving by summing the data in Table D-2. — D12 Table D-2

Annual Savings - More Accurate Method

This method produces the same results as the improved method when the energy and demand charge rates in entries C5 and C3 do not vary with the energy and demand levels.

D13. Do steps D3 through D8 of the basic methodology twelve (12) times, once for each month. Use each month's energy and demand data from Table A-1 in place of A13 and A11, respectively. Also use the appropriate energy and demand rate to match the energy and demand values for steps D4 and D6. Use Table D-3 to enter the results from each step. — D13 Table D-3

D14. Determine the potential annual dollar savings due to peak shaving. Fill in Table D-4 with the appropriate data from Table D-3 and sum. — D14 Table D-4

WORKSHEET D (continued)

Table D-1. Potential Annual Dollar Savings - Approximate Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings			
D6 Demand Dollar Savings			
D7 Surcharge Dollar Savings			
D8 Credit Dollar Increase			
Monthly Dollar Savings (D4 + D6 + D7 - D8)			
Annual Dollar Savings (Monthly Savings X 12)			

WORKSHEET D (continued)

Table D-2. Potential Annual Dollar Savings - Improved Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings			
D6 Demand Dollar Savings			
D7 Surcharge Dollar Savings			
D8 Credit Dollar Increase			
Annual Dollar Savings (D4 + D6 + D7 - D8)			

WORKSHEET D (continued)

Table D-3. Basic Methodology Steps D3 through D8 Applied to More Accurate Method

Month	STEPS					
	D3	D4	D5	D6	D7	D8
Jan						
Feb						
Mar						
Apr						
May						
Jun						
Jul						
Aug						
Sep						
Oct						
Nov						
Dec						

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 5% Peak Shaving

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 10% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 15% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

END OF WORKSHEET D

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SECTION VI

ECONOMIC FEASIBILITY EVALUATION: WORKSHEET E

There are a variety of techniques that can be used for peak shaving at a base. The goal of this worksheet is to provide a method to estimate the total project cost and provide sufficient information to determine which techniques may be most suitable for the base under study.

The result of Worksheet D is the potential annual energy savings that could be attributed to a 5%, 10%, and 15% reduction in the peak demand and associated energy consumption at the base. The next step of the analysis requires a determination of an economically viable technique for accomplishing the reduction. Thus, an economic evaluation leading to proof of cost effectiveness is needed to guide the selection of a peak shaving technique prior to making an investment decision.

A cost-effective method to reduce the utility bill by peak shaving is one that provides dollar savings greater than the expenditures over the economic life of the project. With the potential annual dollar savings known, the maximum expenditure, which includes both the capital investment and the annual operations and maintenance costs, for a cost-effective project can be estimated and compared against the cost of the alternative techniques.

There are a variety of methods for determining cost effectiveness. The Air Force Life Cycle Costing Handbook for the Energy Conservation Investment Programs (ECIP) (Reference 2), utilizes four "modes of analysis" for potential Air Force projects; these are:

(1) Savings-to-Investment Ratio (SIR)
(2) Discounted Payback Period (DPB)
(3) Simple Payback Period (SPB)
(4) Energy-to-Cost Ratio (ECR)

The first two modes of analysis are used in this guidebook as the basis for determining which peak shaving techniques are best suited to a base's energy reduction potential. The assumptions and methodology described herein are consistent with the ECIP guidelines and are based on the National Bureau of Standards Handbook-135 (NBS-135), Life-Cycle Cost Manual for the Federal Energy Management Program (Reference 3).

The savings-to-investment ratio (SIR) is the primary method used by the Air Force for ranking potential energy conservation projects. It is a numerical ratio calculated with the reduction in energy costs, net of increased non-fuel operation and maintenance costs, as the numerator, and the increase in investment costs, minus increased salvage values plus increased replacement costs, as the denominator; all amounts are expressed as present values. An SIR greater than one (1.0) indicates that the investment is cost-

effective; the higher the ratio, the greater the dollar savings per dollar spent and the more attractive the investment.

$$SIR = [\Delta E - \Delta M] \div [\Delta I - \Delta S + \Delta R]$$

where:

ΔE is the Reduction in Energy Costs

ΔM is the Differential Non-fuel O&M Cost

ΔI is the Differential Investment Cost

ΔS is the Differential Salvage Value

ΔR is the Differential Replacement Cost

All amounts are expressed as present values.

The discounted payback period (DPB) is the time required for the cumulative savings from an energy conservation investment to offset, or "pay back," the initial investment cost plus cumulative future costs, taking into account the timing of the cash flows. The shorter the time, the more attractive the investment.

$$DPB = Y \text{ when } \sum_{j=1}^{Y} [\Delta E_j - \Delta M_j - \Delta R_j] = \Delta I$$

where:

ΔI is the Differential Investment Cost

ΔE_o is the Reduction in Annual Energy Costs

ΔM_o is the Differential Annual Non-fuel O&M Cost

ΔR_o is the Differential Annual Replacement Cost

All amounts are expressed as present values; the subscripted amounts are the yearly amounts in constant dollars.

To obtain the present value, in constant dollars, of the yearly cost, the cost must be discounted using the Department of Energy's real "Discount Factors Adjusted For Average Fuel Price Escalation" (Reference 4) and a real 7% discount rate.

In applying these modes of analysis to the peak shaving techniques, two main objectives are to be achieved:

(1) To identify cost-effective projects
(2) To identify those projects that will result in the greatest return to the Air Force budget

Achieving the first objective only requires that an SIR be greater than one (1.0) or the DPB be less than the system economic life. Achieving the second objective requires that a project do much better than meeting the minimum SIR or maximum DPB; for this objective the greater the SIR or the smaller the DPB, the more attractive the project.

In recent years, the Air Force has funded projects with a DPB in the range from three to six years. Depending on the system economic life of the project, this range implies an SIR in the range of 1.5 to 4.5.[1] Table 1 indicates the approximate SIR values for a range of DPB values and different system economic lives. Thus, by assuming a target SIR or DPB value, in conjunction with the potential annual savings determined in Worksheet D, an estimate of the total project cost, including both the initial investment cost and the annually recurring operations and maintenance costs, that meets these objectives can be made. By comparing the estimate of total project cost derived in this manner with the expected project cost for a specific technique, the base civil engineer can decide whether or not further analysis and more detailed studies should be pursued.

Table 1. Approximate SIR Values for Range of DPB Values and Different System Economic Lives

DPB	System Economic Life			
	10	15	20	25
3	2.68	3.48	4.04	4.45
4	2.07	2.69	3.12	3.44
5	1.71	2.22	2.58	2.84
6	1.47	1.91	2.22	2.44
7	1.30	1.69	1.96	2.16
8	1.18	1.53	1.77	1.95
9	1.08	1.40	1.62	1.79
10	1.00	1.30	1.51	1.66

Assumptions:
- Constant annual returns over system economic life
- Investment cost in first year
- No differential escalation rates
- Ratio of annual maintenance cost to investment cost is small

[1]This range is approximate and assumes no differential fuel escalation and constant annual savings over the life of the system.

The methods for reducing electric utility costs vary widely; six methods are discussed in the Introduction to this guide book. Three methods - interconnection, energy control networks, and on-site power generation - are discussed here.

A. INTERCONNECTION

Many Air Force bases, primarily due to incremental growth and construction over the years, have multiple points of entry for purchased electricity. Each point of entry on the base has a master meter from the same or different utility company. Interconnection consolidates the source of electric power supply to one master meter. (Though not discussed here, the principles behind interconnection can also be applied in reverse under certain conditions. Some utility company rate structures may provide incentives to increase the number of meters, hence isolating the peak to one certain master meter.)

The cost savings that can be derived from the interconnection technique occur because the peak demand through a master meter may be considerably less than the sum of the peaks from several meters. That occurs primarily when there are timing differences in the occurrence of the separate peaks. Consolidation will reduce the demand charges if the demand charge rate is the same for all levels of demand and may reduce the demand charges if the rate varies for different levels of demand. An additional cost savings that is not obvious initially can occur because some utilities charge a fixed fee for each master meter. Thus, multiple master meters would increase the utility charges by an amount proportional to the number of master meters in use at a site. Consolidation through interconnection would reduce these fixed charges.

To determine if interconnection is a viable technique, the steps outlined in this guidebook should be modified to evaluate whether or not peak shaving occurs with interconnection. Basically, the steps outlined in Worksheets A and B should be followed for each meter separately. Next, the generic load profiles are compared to determine whether or not the peaks occur at the same time. If they occur at the same time, the peak demand will not be significantly reduced and the only cost savings will come from the reduction in fixed charges. If, on the other hand, the peaks occur at different times, then it is very likely that there will be savings due to peak shaving in addition to reducing the fixed charges. These savings can be estimated by following the steps outlined in Worksheets A and B for the data from all the meters added together as if it were for one meter and subtracting the peak demand from the sum of the separate peaks.

The dollar savings due to the interconnection technique can then be estimated using Worksheet D, substituting the demand savings determined in the manner described above in the appropriate entries. Finally, the dollar savings are used to estimate the total project cost on Worksheet E. The system lifetime for interconnection is usually 15 years.

B. ENERGY MANAGEMENT AND CONTROL SYSTEMS

There are many different types of control systems that are used for a variety of purposes at Air Force facilities. Those associated with peak shaving are commonly labeled: energy management and control systems, central supervisory controls (CSC), radio control systems (RCS), energy monitoring systems (EMS), etc. (In addition to these various automated control devices, many Air Force bases have a plan that is implemented when the utility company notifies a base official that peak shaving is required. Though not discussed here, telephone notification of pre-identified organizations on a base is often accomplished via the Base Energy Action Plan (BEAP), the Demand Avoidance Plan (DAP), etc.)

Energy management and control systems comprise integrated, computer-based information systems and control equipment that accomplish energy savings for heating, ventilating, air conditioning, process equipment, lighting, chillers, and boilers. A related technique that is compatible with EMCS is the radio control system. Both of these systems achieve peak shaving by monitoring and controlling the electrical demand for the base. These types of systems can automatically cycle electrical equipment to reduce the demand under predetermined conditions. The number of cycles and the length of a cycle can be varied to meet various reduction requirements.

The modern EMCS is an efficient and cost-effective technique for reducing energy consumption and peak demand without significantly affecting the services rendered and comfort provided. EMCS is being used extensively in modern buildings and retrofitted for use in older structures.

To determine if EMCS is a viable peak shaving technique, complete Worksheets A through E. Compare the estimated project cost with the expected costs for different types of EMCS and/or RCS to determine which, if any, should be pursued further. The system lifetime for EMCS is usually 15 years.

C. ON-SITE POWER GENERATION

On base resources exist or can be installed to produce electricity in order to avoid a peak in purchased utility power. For bases with simultaneous electrical and thermal loads cogeneration is a potential peak-shaving technique. For bases with considerable emergency or standby generator capacity, these assets can be brought on-line to supplement the demand placed upon the local utility company.

Cogeneration is the simultaneous production of usable thermal energy and electrical energy from a single source. It can save energy by achieving better efficiency in meeting energy requirements. Cogeneration is an on-site generation technique that reduces the demand from the utility because the base is generating its own power. However, the demand savings are not the only savings

attributable to cogeneration; there are fuel savings as well. Because of these different factors, determining the economic feasibility of a cogeneration system can be fairly complex. Thus, the Air Force provides a variety of computational tools and data to evaluate cogeneration system options.

Other on-site power generation techniques that may be considered include the use of backup or standby electrical power generators or a dedicated on-site power plant, which might be a renewable energy source. These systems also reduce the demand from the utility because the base is generating its own power during the peak demand.

To determine if on-site power generation is a viable technique, complete Worksheets A through E. The estimated project cost will be based on energy savings alone and will not provide the complete picture, which should include fuel savings as well. However, the comparison of this amount with the expected project cost should provide sufficient information regarding whether or not to pursue further analysis. The system lifetime for on-site generation systems is usually 25 years.

WORKSHEET E

E1. Enter the DOE Region number for the base location. | E1 ______

E2. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 10 years	E2a	______
b. 15 years	E2b	______
c. 20 years	E2c	______
d. 25 years	E2d	______

E3. Enter the present value (PV) of the 5%, 10%, and 15% savings for system lifetimes of 10, 15, 20, and 25 years in Table E-1. | E3 Table E-1

PV = E2 (UPW factor for 10, 15, 20, and 25 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E4. Enter the estimated total project cost for the different alternatives (calculated in E3) in Table E-2. Assume SIR values of 1, 3, and 5. | E4 Table E-2

Project cost = E3 entry ÷ SIR

(This equation is approximate only and assumes the ratio of maintenance cost to investment cost is low.)

E5. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 3 years	E5a	______
b. 4 years	E5b	______
c. 5 years	E5c	______
d. 6 years	E5d	______

E6. Enter the total project cost for assumed DPB values of 3, 4, 5, and 6 years in Table E-3. | E6 Table E-3

Project cost = E5 (UPW factor for 3, 4, 5, and 6 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E7. Enter the estimated cost range for a peak shaving project based on achieving an SIR = 5 or a DPB = 6 years.

a. 5% peak shaving	E7a	______
b. 10% peak shaving	E7b	______
c. 15% peak shaving	E7c	______

WORKSHEET E (continued)

E8. Enter the expected cost of the alternative peak shaving techniques.

a. Interconnection	E8a	________
b. EMCS	E8b	________
c. On-site power generation	E8c	________

E9. The results from E4 and E6 overlap to illustrate the relationship between the SIR and the DPB. A comparison of E7 with E8 is the basis for pursuing further analysis. An E8 value that is considerably greater than the range of values in E7 is not an economically viable project.

WORKSHEET E (continued)

Table E-1. Present Value of Annual Savings

% Peak Shaving	System Lifetime			
	10 years	15 years	20 years	25 years
5				
10				
15				

Table E-2. Estimated Total Project Cost for SIR = 1, 3, and 5

	% Peak Shaving	System Lifetime			
		10 years	15 years	20 years	25 years
SIR = 1	5				
	10				
	15				
SIR = 3	5				
	10				
	15				
SIR = 5	5				
	10				
	15				

WORKSHEET E (continued)

Table E-3. Estimated Total Project Cost for DPB = 3, 4, 5, and 6 years

% Peak Shaving	Discounted Payback Period			
	3 years	4 years	5 years	6 years
5				
10				
15				

END OF WORKSHEET E

REFERENCES

1. Solar Thermal Plant Impact Analysis and Requirements Definitioin Study, Summary Report for Tasks 1, 2, and 3, Science Applications, Inc., prepared under JPL Contract No. 955238, September 7, 1979

2. Air Force Life Cycle Costing Handbook for the Energy Conservation Investment Programs, 1 December 1984, Headquarters Air Force Engineering and Services Center, Energy Group, Tyndall Air Force Base, Florida 32403

3. Life-Cycle Cost Manual for the Federal Energy Management Program, NBS Handbook-135 (Revised), U. S. Department of Commerce, National Bureau of Standards, DE82017355. Revised 1982.

4. Appendices A, B, and C of the Methodology for Life-Cycle Analysis Using Average Fuel Costs, DOE/CE-0101, U. S. Department of Energy, Office of Federal Energy Management Programs, September 1984.

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APPENDIX A

MIDWEST AIR FORCE BASE I

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WORKSHEET A

A1. Enter the name of the base.	A1	MIDWEST AFB I
A2. Enter the location of the base.	A2	MIDWEST
A3. Enter the electrical utility (or utilities) serving the base.	A3	MIDWEST Co. I
A4. Enter the number of electric meters serving the base.	A4	N.A.
A5. Enter the on-site electrical generation capacity, if any.	A5	N.A.
A6. Enter the site population.		
a. Military	A6a	N.A.
b. Civilian	A6b	N.A.
A7. Enter the facilities on the base.		
a. Number	A7a	N.A.
b. Total area (ft^2)	A7b	N.A.
A8. Enter the buildings on the base.		
a. Number	A8a	N.A.
b. Total area (ft^2)	A8b	N.A.
A9. Enter the housing units on the base.		
a. Number of single-family units	A9a	N.A.
b. Number of multiple-family units	A9b	N.A.
c. Total area (ft^2)	A9c	N.A.
A10. Fill in Table A-1 with the monthly demand and consumption data obtained from the utility bills.	A10	Table A-1
A11. Enter the peak demand; it is the highest value entered in the Demand column of Table A-1.	A11	21400 kW
A12. Enter the peak demand month.	A12	AUGUST
A13. Enter the high month energy consumption; it is the highest value entered in the Energy column of Table A-1.	A13	11.302×10^6 kWh
A14. Enter the sum of the monthly peak demand values by adding the data in the Demand column of Table A-1.	A14	180095 kW
A15. Enter the total annual energy consumption by adding the data in the Energy column of Table A-1.	A15	88.694×10^6 kW

WORKSHEET A (continued)

Table A-1. Demand and Consumption

Month	Demand (kW Peak)	Energy (kWh) ($\times 10^6$)
January	11909	6.960
February	12192	6.192
March	11664	6.600
April	11189	5.616
May	13872	5.976
June	20208	8.496
July	21360	11.280
August	21400	11.302
September	17665	7.827
October	15750	6.096
November	11520	6.517
December	11376	5.832
Total	180095	88.694

END OF WORKSHEET A

WORKSHEET B

B1. Fill in the Demand column of Table B-1 using hourly load data for two average workdays and one normal weekend day obtained from the utility. If 15-minute interval data are provided, calculate the hourly average. Sum each of the three Demand columns and enter the total. — B1 Table B-1

B2. Calculate the average of the three Demand column totals from Table B-1. — B2 351595 kW

B3. Calculate the percent of peak demand. For each hour's entry in the Demand column, divide by the highest value for that day in the same column and enter the result in the adjacent column, % of Peak. — B3 Table B-1

B4. Determine the three-hour period that best represents the late night, flat load level period, A. (Look in Table B-1 around the period from 0300 to 0600 for four entries that are about the same percent.) — B4 0300-0600

B5. Determine the three-hour period that best represents the day peak, flat load level period, B. (Look in Table B-1 around the period from 1200 to 1600 for four entries that are about the same percent.) — B5 1300-1600

B6. Determine the three-hour period that best represents the evening, flat load level period, C. (Look in Table B-1 around the period from 1900 to 2200 for four entries that are about the same percent.) — B6 1800-2100

B7. Determine the average percentage load for the A and C flat load periods for each day; the average percentage load period B is 100%. Fill in Table B-2. — B7 Table B-2

B8. Determine the month's average percentage load for the three flat load periods and enter in Table B-2. If these data are not available, use the following default values for the three flat load periods: — B8 Table B-2

A: Late night period 55%
B: Day peak period 100%
C: Evening period 85%

B9. Plot the generic load profile onto Figure B-1 using the month's average data in Table B-2. — B9 Figure B-1

WORKSHEET B (continued)

Table B-1. Load Profile Hourly Data

	Weekday #1 Date: 5 Aug 83		Weekday #2 Date: 14 Aug 83		Weekend Day Date: 22 Aug 83	
Hour	Demand (kW)	% of Peak	Demand (kW)	% of Peak	Demand (kW)	% of Peak
0100	13077	62.2	13316	63.1	10416	72.3
0200	12466	59.3	12816	60.7	9780	67.9
0300	12047	57.3	12415	58.8	9336	64.8
0400	11830	56.3	12048	57.1	9000	62.4
0500	11616	55.3	12108	57.4	8820	61.2
0600	11784	56.1	12336	58.4	8652	60.0
0700	12828	61.0	13368	63.3	8424	58.5
0800	15180	72.2	15072	71.4	8919	61.9
0900	16848	80.1	16056	76.1	9732	67.5
1000	18000	85.6	17076	80.9	10752	74.6
1100	19166	91.2	18132	85.9	11916	82.7
1200	19858	94.5	19200	91.0	12864	89.3
1300	20507	97.5	20004	94.5	13380	92.8
1400	20952	99.7	20472	97.0	13704	95.1
1500	21024	100	21110	100	14189	98.5
1600	20928	99.5	20952	99.3	14244	98.8
1700	20136	95.8	18732	88.7	14412	100
1800	18564	88.3	17052	80.8	14400	99.9
1900	17364	82.6	15972	75.7	13908	96.5
2000	17376	82.6	15384	72.9	13596	94.3
2100	17106	81.1	15012	71.1	13392	92.9
2200	16560	78.8	14486	68.6	12372	85.8
2300	15636	74.4	13536	64.1	12372	85.8
2400	14532	69.1	12636	59.9	11378	78.9
Total	395382	—	379291	—	279958	—

WORKSHEET B (continued)

Table B-2. Average Percentage Load for Flat Load Level Periods

Date	A: Late Night	B: Day Peak	C: Evening
Weekday #1 5 Aug 83	56.3	100	83.7
Weekday #2 14 Aug 83	57.9	100	75.1
Weekend day 22 Aug 83	62.1	100	95.9
Default Values	55	100	85
Month's Average	57.7	100	84.9

WORKSHEET B (Continued)

Total Area = 351545

5% Area = 4226

10% Area = 9859

15% Area = 17366

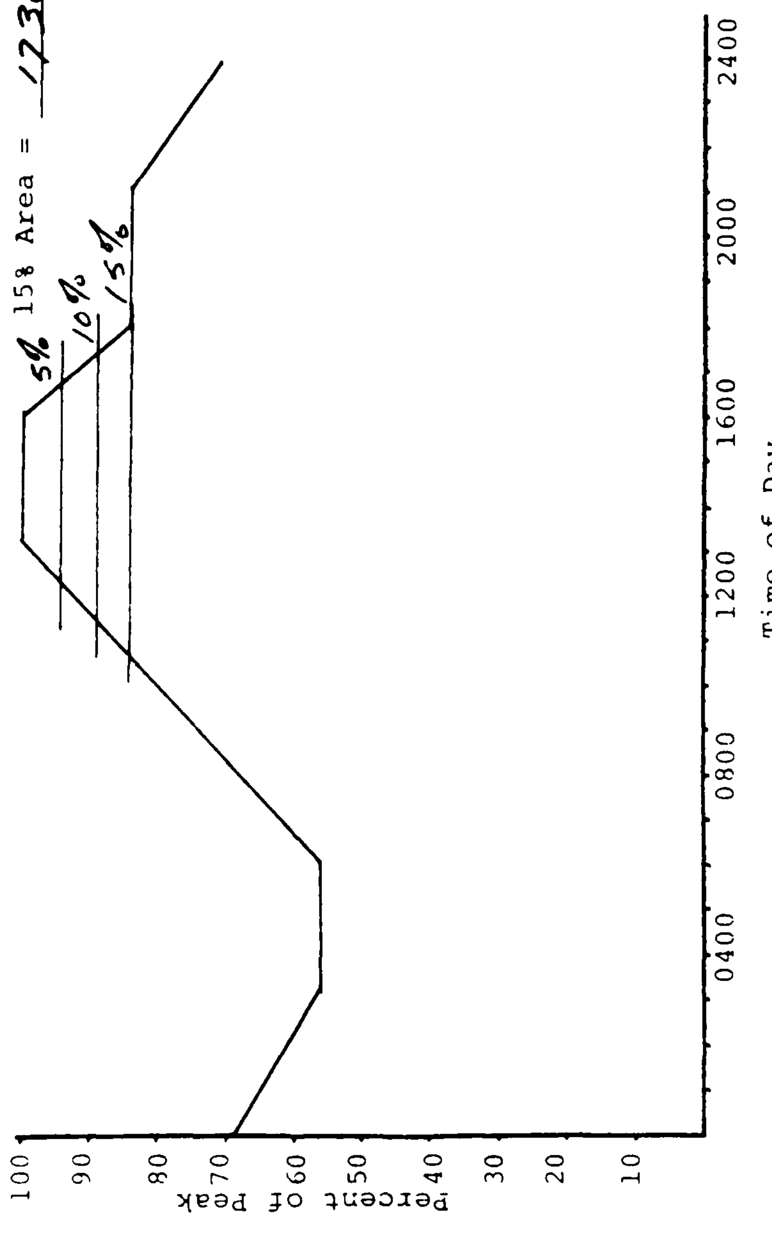

Figure B-1. Plot of the Generic Load Profile

END OF WORKSHEET B

WORKSHEET C

C1.	Enter the peak power demand in the three utility-defined periods in Table C-1. (Either use the utility bill as the source for these data or request the data from the utility.)	C1 Table C-1
C2.	Enter the demand charge rates ($/kW) for on-peak, mid-peak, and off-peak demand for the different kW ranges indicated in Table C-1.	C2 Table C-1
C3.	Enter the actual demand charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total demand charges. (Use the utility bill as the source for these data.)	C3 Table C-1
C4.	Enter the energy consumed in the three utility-defined periods in Table C-1. (Use the utility bill as the source for these data.)	C4 Table C-1
C5.	Enter the energy charge rates ($/kWh) for on-peak, mid-peak, and off-peak energy consumption or for the different kWh ranges indicated in Table C-1.	C5 Table C-1
C6.	Enter the actual energy charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total energy charges. (Use the utility bill as the source for these data.)	C6 Table C-1
C7.	Enter the total for each entry in Table C-1 in the Total column.	C7 Table C-1

C8. Enter the surcharges that are listed on the utility bill.

a. Fuel adjustment (.00228 $/kWh)	C8a	$25718
b. Customer charges	C8b	—
c. Equipment rental	C8c	$706
d. R&D fund	C8d	—
e. Other	C8e	—
f. Total Surcharges (sum C8a through C8e)	C8f	$26415

C9. Enter the credits that are listed on the utility bill.

a. Transformer	C9a	—
b. Power factor adjustment	C9b	$305
c. Other	C9c	$71760
d. Total Credits (sum C9a through C9c)	C9d	$72065

WORKSHEET C (continued)

C10. Enter the net additional charges. (C8f minus C9d) — C10 -$45650

C11. Enter the total actual payments (Total demand charges from Table C-1 + Total energy charges from Table C-1 + C10) — C11 $530350

WORKSHEET C (continued)

Table C-1. Demand and Consumption Data

Utility Bill Entry	Time of Day			Total
	On-peak	Mid-peak	Off-peak	
Peak Power Demand (kW)	21400		19680	-----
Demand Charge Rates ($/kW)				
0 to ____ kW	$9.50	$9.50	$9.50	-----
____ to ____ kW				-----
____ to ____ kW				-----
Demand Charges ($)				
0 to X kW				
X to Y kW				
Y to Z kW				
Total Demand Charges	$202920			$202920
Energy Consumed (kWh)	4104000	—	7176000	11280000
Energy Charge Rates ($/kWh)				
0 to ____ kWh	$0.033	$0.033	$0.033	-----
____ to ____ kWh				-----
____ to ____ kWh				-----
Energy Charges ($)				
0 to X kWh				
X to Y kWh				
Y to Z kWh				
Total Energy Charges	$373080			$373080

END OF WORKSHEET C

WORKSHEET D

Basic Methodology

D1. Mark the 5%, 10%, and 15% peak shaving levels on the generic load profile curve, Figure B-1 of Worksheet B. — D1 Figure B-1

D2. Calculate the energy reduction factor, r, corresponding to the 5%, 10%, and 15% peak shaving levels. Divide the area that represents the 5%, 10%, and 15% reduction levels by the total area under the generic load profile curve.

- a. 5% energy reduction factor — D2a 0.012
- b. 10% energy reduction factor — D2b 0.028
- c. 15% energy reduction factor — D2c 0.049

If the default generic load profile curve was used for Figure B-1, enter the default values as follows:

for 5% reduction, r = 0.013
for 10% reduction, r = 0.03
for 15% reduction, r = 0.05

D3. Calculate the energy reduction for the month under analysis for each level of peak shaving.

- a. for 5%, D2a x A13 — D3a 135624 kWh
- b. for 10%, D2b x A13 — D3b 316456 kWh
- c. for 15%, D2c x A13 — D3c 553798 kWh

D4. Calculate the dollar savings due to the reduction of energy consumption. Use the highest C5 entry from Worksheet C, which is the energy rate in $/kWh. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D4 Table D-1

- a. for 5%, D3a x C5
- b. for 10%, D3b x C5
- c. for 15%, D3c x C5

D5. Calculate the peak demand reduction for the 5%, 10%, and 15% reduction levels.

- a. for 5%, A11 x 0.05 — D5a 1070 kW
- b. for 10%, A11 x 0.10 — D5b 2140 kW
- c. for 15%, A11 x 0.15 — D5c 3210 kW

D6. Calculate the dollar savings due to the reduction of peak demand. Use the highest C2 entry from Worksheet C, which is the demand rate in $/kW. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D6 Table D-1

- a. for 5%, D5a x C2
- b. for 10%, D5b x C2
- c. for 15%, D5c x C2

D7. Calculate the surcharge reduction, if applicable, and enter in Table D-1. For an energy-related surcharge (i.e, $/kWh), the dollar savings would be as follows: D7 Table D-1

a. for 5%, surcharge rate from C8 entry x D3a
b. for 10%, surcharge rate from C8 entry x D3b
c. for 15%, surcharge rate from C8 entry x D3c

For a demand-related surcharge (i.e., $/kW), the dollar savings would be as follows:

d. for 5%, surcharge rate from C8 entry x D5a
e. for 10%, surcharge rate from C8 entry x D5b
f. for 15%, surcharge rate from C8 entry x D5c

D8. Calculate the credit increase, if applicable, and enter in Table D-1. For an energy-related credit (i.e., $/kWh), the dollar savings would be as follows: D8 Table D-1

a. for 5%, credit rate from C9 entry x D3a
b. for 10%, credit rate from C9 entry x D3b
c. for 15%, credit rate from C9 entry x D3c

For a demand-related credit (i.e., $/kW), the dollar savings would be as follows:

a. for 5%, credit rate from C9 entry x D5a
b. for 10%, credit rate from C9 entry x D5b
c. for 15%, credit rate from C9 entry x D5c

D9. Determine the potential monthly dollar savings due to peak shaving by summing the data in Table D-1. D9 Table D-1

Annual Savings - Approximate Method

This method will overstate the annual savings.

D10. To approximate the annual savings due to peak shaving, multiply the Monthly Dollar Savings by 12 in Table D-1. D10 Table D-1

Annual Savings - Improved Method

D11. Do steps D3 through D8 of the basic methodology using A15 and A14 in place of A13 and A11, respectively.

Step D3: D2a x A15 D11a 1064328 kWh
D2b x A15 D11b 2483432 kWh
D2c x A15 D11c 4346006 kWh

Step D4: D11a x C5 D11d Table D-2
D11b x C5
D11c x C5

WORKSHEET D (continued)

Step D5:	A14 x 0.05	D11e	9005
	A14 x 0.10	D11f	18010
	A14 x 0.15	D11g	27014
Step D6:	D11e x C2	D11h	Table D-2
	D11f x C2		
	D11g x C2		
Step D7:	D11a x C8	D11i	Table D-2
	D11b x C8		
	D11c x C8		
Step D8:	D11e x C9	D11j	Table D-2
	D11f x C9		
	D11g x C9		

D12. Determine the potential annual dollar savings due to peak shaving by summing the data in Table D-2. — D12 Table D-2

Annual Savings - More Accurate Method

This method produces the same results as the improved method when the energy and demand charge rates in entries C5 and C3 do not vary with the energy and demand levels.

D13. Do steps D3 through D8 of the basic methodology twelve (12) times, once for each month. Use each month's energy and demand data from Table A-1 in place of A13 and A11, respectively. Also use the appropriate energy and demand rate to match the energy and demand values for steps D4 and D6. Use Table D-3 to enter the results from each step. — D13 Table D-3

D14. Determine the potential annual dollar savings due to peak shaving. Fill in Table D-4 with the appropriate data from Table D-3 and sum. — D14 Table D-4

WORKSHEET D (continued)

Table D-1. Potential Annual Dollar Savings - Approximate Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings	4476	10443	18275
D6 Demand Dollar Savings	10165	20330	30495
D7 Surcharge Dollar Savings	309	722	1263
D8 Credit Dollar Increase	—	—	—
Monthly Dollar Savings (D4 + D6 + D7 - D8)	14950	31495	50033
Annual Dollar Savings (Monthly Savings X 12)	$179400	$377940	$600396

WORKSHEET D (continued)

Table D-2. Potential Annual Dollar Savings - Improved Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings	35123	81953	143418
D6 Demand Dollar Savings	85548	171095	256633
D7 Surcharge Dollar Savings	2427	5662	9099
D8 Credit Dollar Increase	—	—	—
Annual Dollar Savings (D4 + D6 + D7 - D8)	$123098	$258710	$409150

WORKSHEET D (continued)

Table D-3. Basic Methodology Steps D3 through D8
Applied to More Accurate Method

Month	STEPS					
	D3	D4	D5	D6	D7	D8
Jan						
Feb						
Mar						
Apr		N.A. FOR THIS CASE				
May						
Jun						
Jul						
Aug						
Sep						
Oct						
Nov						
Dec						

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 5% Peak Shaving

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

N.A. FOR THIS CASE

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 10% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr		N.A. FOR THIS CASE			
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 15% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr		N.A. FOR THIS CASE			
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

END OF WORKSHEET D

WORKSHEET E

E1. Enter the DOE Region number for the base location. E1 5 TABLE B-5a

E2. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 10 years — E2a 7.23
b. 15 years — E2b 9.11
c. 20 years — E2c 10.32
d. 25 years — E2d 11.10

E3. Enter the present value (PV) of the 5%, 10%, and 15% savings for system lifetimes of 10, 15, 20, and 25 years in Table E-1. — E3 Table E-1

PV = E2 (UPW factor for 10, 15, 20, and 25 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E4. Enter the estimated total project cost for the different alternatives (calculated in E3) in Table E-2. Assume SIR values of 1, 3, and 5. — E4 Table E-2

Project cost = E3 entry ÷ SIR

(This equation is approximate only and assumes the ratio of maintenance cost to investment cost is low.)

E5. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 3 years — E5a 2.74
b. 4 years — E5b 3.56
c. 5 years — E5c 4.32
d. 6 years — E5d 5.01

E6. Enter the total project cost for assumed DPB values of 3, 4, 5, and 6 years in Table E-3. — E6 Table E-3

Project cost = E5 (UPW factor for 3, 4, 5, and 6 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E7. Enter the estimated cost range for a peak shaving project based on achieving an SIR = 5 or a DPB = 6 years.

a. 5% peak shaving — E7a $175K-600K
b. 10% peak shaving — E7b $375K-1,300K
c. 15% peak shaving — E7c $590K-2,000K

WORKSHEET E (continued)

E8. Enter the expected cost of the alternative peak shaving techniques.

a. Interconnection	E8a	$50K*
b. EMCS	E8b	$1M**
c. On-site power generation	E8c	$2.2 m 5%; $4.9 m 10%; $8.0 m 15%. ***

E9. The results from E4 and E6 overlap to illustrate the relationship between the SIR and the DPB. A comparison of E7 with E8 is the basis for pursuing further analysis. An E8 value that is considerably greater than the range of values in E7 is not an economically viable project.

* TWO MILE DISTANCE.

** DEDICATED HARD-WIRED SYSTEM; 1000 STATIONS.

*** DIESEL SYSTEM; HEAT CREDIT NOT INCLUDED.

E9 CONCLUSION FOR THIS CASE

INTERCONNECTION - POTENTIALLY VIABLE TECHNIQUE; FURTHER STUDY SHOULD BE PURSUED

EMCS - POTENTIALLY VIABLE TECHNIQUE; FURTHER STUDY SHOULD BE PURSUED.

ON-SITE GENERATION - EXPECTED COST SIGNIFICANTLY GREATER THAN ESTIMATED COST RANGE; MOST LIKELY NOT A VIABLE TECHNIQUE.

Table E-1. Present Value of Annual Savings

% Peak Shaving	System Lifetime			
	10 years	15 years	20 years	25 years
5	889,999	1,121,423	1,270,371	1,366,388
10	1,870,473	2,356,848	2,669,887	2,871,681
15	2,958,155	3,727,357	4,222,428	4,541,565

Table E-2. Estimated Total Project Cost for SIR = 1, 3, and 5.

	% Peak Shaving	System Lifetime			
		10 years	15 years	20 years	25 years
SIR = 1	5	889,999	1,121,423	1,270,371	1,366,388
	10	1,870,473	2,356,848	2,669,887	2,871,681
	15	2,958,155	3,727,357	4,222,428	4,541,565
SIR = 3	5	296,666	373,808	423,457	455,463
	10	623,491	785,616	889,962	957,227
	15	986,052	1,242,452	1,407,476	1,513,855
SIR = 5	5	178,000	224,285	254,074	273,278
	10	374,095	471,370	533,977	574,336
	15	591,631	745,471	844,486	908,313

WORKSHEET E (continued)

Table E-3. Estimated Total Project Cost for DPB = 3, 4, 5, and 6 years

% Peak Shaving	Discounted Payback Period			
	3 years	4 years	5 years	6 years
5	337,289	438,229	531,783	616,721
10	708,865	921,008	1,117,627	1,296,137
15	1,121,071	1,456,574	1,767,528	2,049,892

END OF WORKSHEET E

APPENDIX B

MIDWEST AIR FORCE BASE II

(The reverse of this page is blank.)

WORKSHEET A

A1.	Enter the name of the base.	A1 MIDWEST AFB II
A2.	Enter the location of the base.	A2 MIDWEST
A3.	Enter the electrical utility (or utilities) serving the base.	A3 MIDWEST CO II
A4.	Enter the number of electric meters serving the base.	A4 N.A.
A5.	Enter the on-site electrical generation capacity, if any.	A5 N.A.
A6.	Enter the site population.	
	a. Military	A6a N.A.
	b. Civilian	A6b N.A.
A7.	Enter the facilities on the base.	
	a. Number	A7a N.A.
	b. Total area (ft^2)	A7b N.A.
A8.	Enter the buildings on the base.	
	a. Number	A8a N.A.
	b. Total area (ft^2)	A8b N.A.
A9.	Enter the housing units on the base.	
	a. Number of single-family units	A9a N.A.
	b. Number of multiple-family units	A9b N.A.
	c. Total area (ft^2)	A9c N.A.
A10.	Fill in Table A-1 with the monthly demand and consumption data obtained from the utility bills.	A10 Table A-1
A11.	Enter the peak demand; it is the highest value entered in the Demand column of Table A-1.	A11 9975 kW
A12.	Enter the peak demand month.	A12 July
A13.	Enter the high month energy consumption; it is the highest value entered in the Energy column of Table A-1.	A13 4.865×10^6 kWh
A14.	Enter the sum of the monthly peak demand values by adding the data in the Demand column of Table A-1.	A14 91158 kW
A15.	Enter the total annual energy consumption by adding the data in the Energy column of Table A-1.	A15 38.112×10^6 kWh

WORKSHEET A (continued)

Table A-1. Demand and Consumption

Month	Demand (kW Peak)	Energy (kWh) $(\times 10^6)$
January	6534	2.829
February	6534	2.967
March	6522	2.510
April	6504	2.365
May	6416	2.629
June	8619	3.602
July	9975	4.568
August	9761	4.865
September	9736	3.613
October	7563	2.624
November	6482	2.784
December	6512	2.756
Total	91158	38.112

END OF WORKSHEET A

WORKSHEET B

B1.	Fill in the Demand column of Table B-1 using hourly load data for two average workdays and one normal weekend day obtained from the utility. If 15-minute interval data are provided, calculate the hourly average. Sum each of the three Demand columns and enter the total.	B1 Table B-1
B2.	Calculate the average of the three Demand column totals from Table B-1.	B2 *N.A.*
B3.	Calculate the percent of peak demand. For each hour's entry in the Demand column, divide by the highest value for that day in the same column and enter the result in the adjacent column, % of Peak.	B3 Table B-1
B4.	Determine the three-hour period that best represents the late night, flat load level period, A. (Look in Table B-1 around the period from 0300 to 0600 for four entries that are about the same percent.)	B4 *0300-0600*
B5.	Determine the three-hour period that best represents the day peak, flat load level period, B. (Look in Table B-1 around the period from 1200 to 1600 for four entries that are about the same percent.)	B5 *1200-1600*
B6.	Determine the three-hour period that best represents the evening, flat load level period, C. (Look in Table B-1 around the period from 1900 to 2200 for four entries that are about the same percent.)	B6 *1900-2200*
B7.	Determine the average percentage load for the A and C flat load periods for each day; the average percentage load period B is 100%. Fill in Table B-2.	B7 Table B-2
B8.	Determine the month's average percentage load for the three flat load periods and enter in Table B-2. If these data are not available, use the following default values for the three flat load periods:	B8 Table B-2

A:	Late night period	55%
B:	Day peak period	100%
C:	Evening period	85%

B9.	Plot the generic load profile onto Figure B-1 using the month's average data in Table B-2.	B9 Figure B-1

WORKSHEET B (continued)

Table B-1. Load Profile Hourly Data

	Weekday #1 Date: ________		Weekday #2 Date: ________		Weekend Day Date: ________	
Hour	Demand (kW)	% of Peak	Demand (kW)	% of Peak	Demand (kW)	% of Peak
0100						
0200						
0300						
0400						
0500						
0600						
0700						
0800						
0900						
1000						
1100						
1200						
1300						
1400						
1500						
1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
2400						
Total		----		----		----

N.A. FOR THIS CASE
DEFAULT VALUES ARE USED

WORKSHEET B (continued)

Table B-2. Average Percentage Load for Flat Load Level Periods

Date	A: Late Night	B: Day Peak	C: Evening
Weekday #1	N.A.	100	N.A.
Weekday #2	N.A.	100	N.A.
Weekend day	N.A.	100	N.A.
Default Values	55	100	85
Month's Average	55	100	85

WORKSHEET B (Continued)

Total Area = DEFAULT VALUES USED.

5% Area = DO NOT HAVE

10% Area = TO CALCULATE

15% Area = ______

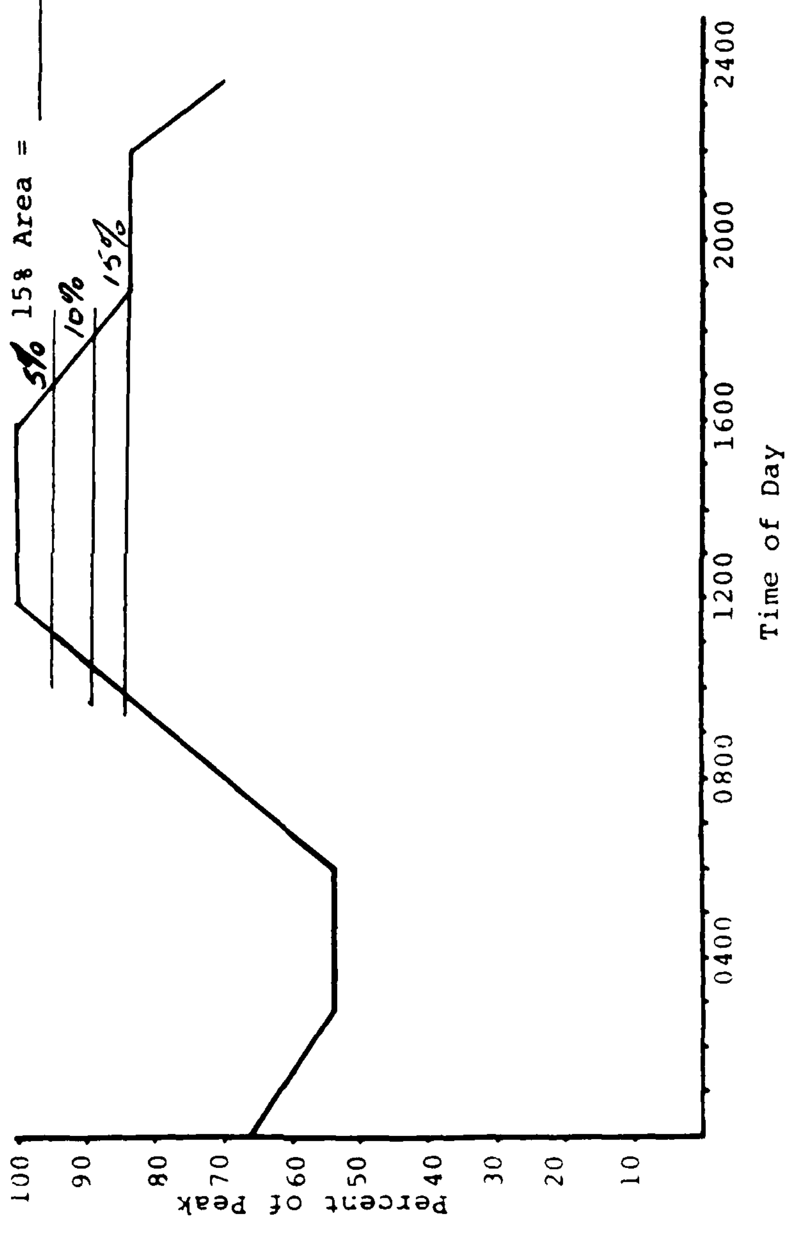

Figure B-1. Plot of the Generic Load Profile

END OF WORKSHEET B

WORKSHEET C

C1.	Enter the peak power demand in the three utility-defined periods in Table C-1. (Either use the utility bill as the source for these data or request the data from the utility.)	C1	Table C-1
C2.	Enter the demand charge rates ($/kW) for on-peak, mid-peak, and off-peak demand for the different kW ranges indicated in Table C-1.	C2	Table C-1
C3.	Enter the actual demand charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total demand charges. (Use the utility bill as the source for these data.)	C3	Table C-1
C4.	Enter the energy consumed in the three utility-defined periods in Table C-1. (Use the utility bill as the source for these data.)	C4	Table C-1
C5.	Enter the energy charge rates ($/kWh) for on-peak, mid-peak, and off-peak energy consumption or for the different kWh ranges indicated in Table C-1.	C5	Table C-1
C6.	Enter the actual energy charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total energy charges. (Use the utility bill as the source for these data.)	C6	Table C-1
C7.	Enter the total for each entry in Table C-1 in the Total column.	C7	Table C-1
C8.	Enter the surcharges that are listed on the utility bill.		
	a. Fuel adjustment (.00925 $/kWh)	C8a	$45000
	b. Customer charges	C8b	—
	c. Equipment rental	C8c	$1000
	d. R&D fund	C8d	—
	e. Other	C8e	—
	f. Total Surcharges (sum C8a through C8e)	C8f	$46000
C9.	Enter the credits that are listed on the utility bill.		
	a. Transformer	C9a	—
	b. Power factor adjustment	C9b	—
	c. Other	C9c	—
	d. Total Credits (sum C9a through C9c)	C9d	—

WORKSHEET C (continued)

C10. Enter the net additional charges. (C8f minus C9d)
C10 $46000

C11. Enter the total actual payments (Total demand charges from Table C-1 + Total energy charges from Table C-1 + C10)
C11 $228050

WORKSHEET C (continued)

Table C-1. Demand and Consumption Data

Utility Bill Entry	Time of Day: On-peak	Time of Day: Mid-peak	Time of Day: Off-peak	Total
Peak Power Demand (kW)	9761			-----
Demand Charge Rates ($/kW)				
0 to 40 kW	$10.00			-----
40 to + kW	$7.97			-----
to kW				-----
Demand Charges ($)				
0 to ~~X~~ 40 kW	$400			$400
~~X~~ 40 to ~~Y~~ + kW	$77468			$77468
Y to Z kW				
Total Demand Charges	$77868			$77868
Energy Consumed (kWh)	4865000			4865000
Energy Charge Rates ($/kWh)				
0 to 20000 kWh	$0.0276			-----
20000 to 100000 kWh	$0.0250			-----
100000 to 1000000 kWh	$0.0222			-----
1000000 +	$0.0211			
Energy Charges ($)				
0 to ~~X~~ 20000 kWh	$572			$572
~~X~~ 20000 to ~~Y~~ 100000 kWh	$2000			$2000
~~Y~~ 100000 to ~~Z~~ 1000000 kWh	$19980			$19980
1000000	$81550			$81550
Total Energy Charges	$104182			$104182

END OF WORKSHEET C

WORKSHEET D

Basic Methodology

D1. Mark the 5%, 10%, and 15% peak shaving levels on the generic load profile curve, Figure B-1 of Worksheet B. — D1 Figure B-1

D2. Calculate the energy reduction factor, r, corresponding to the 5%, 10%, and 15% peak shaving levels. Divide the area that represents the 5%, 10%, and 15% reduction levels by the total area under the generic load profile curve.

a. 5% energy reduction factor — D2a 0.013
b. 10% energy reduction factor — D2b 0.03
c. 15% energy reduction factor — D2c 0.05

If the default generic load profile curve was used for Figure B-1, enter the default values as follows:

for 5% reduction, r = 0.013
for 10% reduction, r = 0.03
for 15% reduction, r = 0.05

D3. Calculate the energy reduction for the month under analysis for each level of peak shaving.

a. for 5%, D2a x A13 — D3a 63245 kWh
b. for 10%, D2b x A13 — D3b 145950 kWh
c. for 15%, D2c x A13 — D3c 243250 kWh

D4. Calculate the dollar savings due to the reduction of energy consumption. Use the highest C5 entry from Worksheet C, which is the energy rate in $/kWh. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D4 Table D-1

a. for 5%, D3a x C5
b. for 10%, D3b x C5
c. for 15%, D3c x C5

D5. Calculate the peak demand reduction for the 5%, 10%, and 15% reduction levels.

a. for 5%, A11 x 0.05 — D5a 499 kW
b. for 10%, A11 x [illegible] — D5b 998 kW
c. for 15%, A11 x [illegible] — D5c 1496 kW

D6. Calculate the dollar savings due to the reduction of peak demand. Use the highest [illegible] entry from Worksheet [illegible], which is the demand rate in $/kW. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1. — D6 Table D-1

a. [illegible]
b. [illegible]
c. [illegible]

D7. Calculate the surcharge reduction, if applicable, and enter in Table D-1. For an energy-related surcharge (i.e, $/kWh), the dollar savings would be as follows: a. for 5%, surcharge rate from C8 entry x D3a b. for 10%, surcharge rate from C8 entry x D3b c. for 15%, surcharge rate from C8 entry x D3c For a demand-related surcharge (i.e., $/kW), the dollar savings would be as follows: d. for 5%, surcharge rate from C8 entry x D5a e. for 10%, surcharge rate from C8 entry x D5b f. for 15%, surcharge rate from C8 entry x D5c	D7 Table D-1
D8. Calculate the credit increase, if applicable, and enter in Table D-1. For an energy-related credit (i.e., $/kWh), the dollar savings would be as follows: a. for 5%, credit rate from C9 entry x D3a b. for 10%, credit rate from C9 entry x D3b c. for 15%, credit rate from C9 entry x D3c For a demand-related credit (i.e., $/kW), the dollar savings would be as follows: a. for 5%, credit rate from C9 entry x D5a b. for 10%, credit rate from C9 entry x D5b c. for 15%, credit rate from C9 entry x D5c	D8 Table D-1
D9. Determine the potential monthly dollar savings due to peak shaving by summing the data in Table D-1.	D9 Table D-1

Annual Savings - Approximate Method

This method will overstate the annual savings.

D10. To approximate the annual savings due to peak shaving, multiply the Monthly Dollar Savings by 12 in Table D-1.	D10 Table D-1

Annual Savings - Improved Method

D11. Repeat steps D3 through D8 of the basic methodology using A15 and A14 in place of A10 and A11, respectively.	
Step D3: D2a x A15 D2b x A15 D2c x A15	D11a 495456 kWh D11b 1143360 kWh D11c 1905600 kWh
Step D4: D11a x C5 D11b x C5 D11c x C5	D11d Table D-2

Step D5:	A14 x 0.05	D11e	4558
	A14 x 0.10	D11f	9116
	A14 x 0.15	D11g	13674
Step D6:	D11e x C2	D11h	Table D-2
	D11f x C2		
	D11g x C2		
Step D7:	D11a x C8	D11i	Table D-2
	D11b x C8		
	D11c x C8		
Step D8:	D11e x C9	D11j	Table D-2
	D11f x C9		
	D11g x C9		

D12. Determine the potential annual dollar savings due to peak shaving by summing the data in Table D-2. — D12 Table D-2

Annual Savings - More Accurate Method

This method produces the same results as the improved method when the energy and demand charge rates in entries C5 and C3 do not vary with the energy and demand levels.

D13. Do steps D3 through D8 of the basic methodology twelve (12) times, once for each month. Use each month's energy and demand data from Table A-1 in place of A13 and A11, respectively. Also use the appropriate energy and demand rate to match the energy and demand values for steps D4 and D6. Use Table D-3 to enter the results from each step. — D13 Table D-3

D14. Determine the potential annual dollar savings due to peak shaving. Fill in Table D-4 with the appropriate data from Table D-3 and sum. — D14 Table D-4

[illegible]	334	3080	5133
[illegible]	3977	7954	923
[illegible]	585	1350	2250
[illegible]	—	—	—
[illegible]	$5896	$12384	$19306
Annual Dollar Savings [illegible]	$70752	$148608	$231672

WORKSHEET D continued

Table [illegible]. Potential Annual Dollar Savings - Improved Method

Contributor to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings	10454	24125	40208
D6 Demand Dollar Savings	36327	72655	108982
D7 Surcharge Dollar Savings	4583	10576	17627
D8 Credit Dollar Increase	—	—	—
Annual Dollar Savings (D4 + D6 + D7 - D8)	$51364	$107356	$166817

WORKSHEET D (continued)

Table D-3. Basic Methodology Steps D3 through D8 Applied to More Accurate Method

Month	STEPS					
	D3	D4	D5	D6	D7	D8
Jan	36777 84870 141450	776 1791 2985	327 653 980	2604 5208 7811	340 785 1308	—
Feb	38571 89010 148350	814 1878 3130	327 653 980	2604 5208 7811	357 823 1372	—
Mar	32630 75300 125500	688 1583 2648	326 652 978	2599 5198 7797	302 697 1161	—
Apr	30745 70950 118250	649 1497 2495	325 650 974	2592 5184 7776	284 656 1094	—
May	34177 78870 131450	721 1664 2774	321 641 962	2557 5114 7670	316 730 1216	—
Jun	46826 108060 180100	988 2280 3800	431 862 1293	3435 6869 10304	433 1000 1666	—
Jul	59389 137040 228400	1253 2892 4819	499 998 1496	3975 7950 11925	549 1268 2113	—
Aug	63245 145950 243250	1334 3080 5133	488 976 1464	3890 7780 11669	585 1350 2250	—
Sep	46969 108390 180650	991 2287 3812	487 974 1460	3880 7760 11639	434 1003 1671	—
Oct	34112 78720 131200	720 1661 2768	378 756 1134	3014 6028 9042	316 728 1214	—
Nov	36192 83520 139200	764 1762 2937	324 648 972	2583 5166 7749	335 773 1288	—
Dec	35828 82680 137800	756 1745 2908	326 651 977	2595 5190 7785	331 765 1275	—

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 5% Peak Shaving

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan	776	2609	340	—	3720
Feb	814	2604	357	—	3775
Mar	688	2599	302	—	3589
Apr	649	2592	284	—	3525
May	721	2557	316	—	3594
Jun	988	3435	433	—	4856
Jul	1253	3975	549	—	5777
Aug	1334	3890	585	—	5809
Sep	991	3880	434	—	5305
Oct	720	3014	316	—	4050
Nov	764	2583	335	—	3682
Dec	756	2595	331	—	3682
Total Annual Savings	10454	36328	4582	—	$51364

WORKSHEET [illegible]

Table [illegible] Annual Savings from [illegible]

[illegible] Peak [illegible]

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increase (D8)	Total Monthly Savings (D4 + D6 + [illegible])
Jan	1791	5208	785	—	7784
Feb	1878	5208	823	—	7909
Mar	1589	5198	697	—	7484
Apr	1497	5184	656	—	7337
May	1669	5119	730	—	7508
Jun	2280	6869	1000	—	10149
Jul	2892	7950	1268	—	12110
Aug	3080	7780	1350	—	12210
Sep	2287	7760	1003	—	11050
Oct	1661	6028	728	—	8417
Nov	1762	5166	773	—	7701
Dec	1745	5190	765	—	7700
Total Annual Savings	24126	72655	10578	—	$107359

WORKSHEET D (Continued)

Table [illegible]-4. Annual Savings from More Accurate Meters for [illegible] Peak Shaving (Continued)

Month	Energy Savings (14)	Demand Savings (16)	Surcharge Savings (17)	Credit Increases (18)	Total Monthly Savings (14 + 16 + 17 [illegible])
Jan	2985	7811	1308	—	12104
Feb	3130	7811	1372	—	12313
Mar	2648	7797	1161	—	11606
Apr	2494	7776	1094	—	11364
May	2774	7670	1216	—	11660
Jun	3800	10304	1666	—	15770
Jul	4819	11925	2113	—	18857
Aug	5133	11669	2250	—	19052
Sep	3812	11639	1671	—	17122
Oct	2768	9042	1214	—	13024
Nov	2937	7749	1288	—	11974
Dec	2908	7785	1275	—	11968
Total Annual Savings	40208	108978	17628	—	$166814

END OF WORKSHEET D

WORKSHEET E

E1. Enter the [illegible] from the case table. E1 *7 TABLE 6-7a*

E2. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 10 years E2a *7.23*
b. 15 years E2b *9.16*
c. 20 years E2c *10.42*
d. 25 years E2d *11.35*

E3. Enter the present value (PV) of the 5%, 10%, and 15% savings for system lifetimes of 10, 15, 20, and 25 years in Table E-1. E3 Table E-1

PV = E2 (UPW factor for 10, 15, 20, and 25 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E4. Enter the estimated total project cost for the different alternatives (calculated in E3) in Table E-2. Assume SIR values of 1, 3, and 5. E4 Table E-2

Project cost = E3 entry ÷ SIR

(This equation is approximate only and assumes the ratio of maintenance cost to investment cost is low.)

E5. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 3 years E5a *2.88*
b. 4 years E5b *3.68*
c. 5 years E5c *4.41*
d. 6 years E5d *5.07*

E6. Enter the total project cost for assumed DPB values of 3, 4, 5, and 6 years in Table E-3. E6 Table E-3

Project cost = E5 (UPW factor for 3, 4, 5, and 6 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E7. Enter the estimated cost range for a peak shaving project based on achieving an SIR = 5 or a DPB = 6 years.

a. 5% peak shaving E7a *$75K-260K*
b. 10% peak shaving E7b *$155K-545K*
c. 15% peak shaving E7c *$240K-845K*

WORKSHEET E (continued)

E8. Enter the expected cost of the alternative peak shaving techniques.

a. Interconnection — E8a $12.5K*

b. EMCS — E8b $500K**

c. On-site power generation — E8c $1.1M for 5%*** / $2.3M for 10% / $3.6M for 15%

E9. The results from E4 and E6 overlap to illustrate the relationship between the SIR and the DPB. A comparison of E7 with E8 is the basis for pursuing further analysis. An E8 value that is considerably greater than the range of values in E7 is not an economically viable project.

* HALF MILE DISTANCE.

** DEDICATED HARD-WIRED SYSTEM; 500 STATIONS.

*** DIESEL SYSTEM; HEAT CREDIT NOT INCLUDED.

E9 CONCLUSION FOR THIS CASE

INTERCONNECTION - POTENTIALLY VIABLE TECHNIQUE; FURTHER STUDY SHOULD BE PURSUED.

EMCS - POTENTIALLY VIABLE TECHNIQUE IF 15% PEAK SHAVING CAN BE ACHIEVED; FURTHER STUDY SHOULD BE PURSUED.

ON-SITE GENERATION - EXPECTED COST SIGNIFICANTLY GREATER THAN ESTIMATED COST RANGE; MOST LIKELY NOT A VIABLE TECHNIQUE.

WORKSHEET E (Continued)

Table E-1. Present Value of Annual Savings

% Peak Shaving	System Lifetime			
	10 years	15 years	20 years	25 years
5	371,362	470,494	537,781	582,981
10	776,184	983,301	1,124,017	1,218,491
15	1,206,087	1,528,044	1,746,574	1,893,373

Table E-2. Estimated Total Project Cost for SIR = 1, 3, and 5.

	% Peak Shaving	System Lifetime			
		10 years	15 years	20 years	25 years
SIR = 1	5	371,362	470,494	537,781	582,981
	10	776,184	983,301	1,124,017	1,218,491
	15	1,206,087	1,528,044	1,746,574	1,893,373
SIR = 3	5	123,787	156,831	179,260	194,327
	10	258,728	327,767	374,672	406,164
	15	402,029	509,348	582,191	631,124
SIR = 5	5	74,272	94,099	107,556	116,596
	10	155,236	196,660	224,803	243,698
	15	241,217	305,609	349,315	378,675

WORKSHEET E (continued)

Table E-3. Estimated Total Project Cost for DPB = 3, 4, 5, and 6 years

% Peak Shaving	Discounted Payback Period			
	3 years	4 years	5 years	6 years
5	147,928	189,020	226,515	260,415
10	309,185	395,070	473,440	544,295
15	480,433	613,887	735,663	845,762

END OF WORKSHEET E

APPENDIX C

SOUTHEAST AIR FORCE BASE

(The reverse of this page is blank.)

ATTACHMENT A

A1.	Enter the name of the base.	A1.	SOUTHEAST AFB
A2.	Enter the location of the base.	A2	SOUTHEAST
A3.	Enter the electrical utility (or utilities serving the base.	A3	SOUTHEAST Co
A4.	Enter the number of electric meters serving the base.	A4	NA
A5.	Enter the on-site electrical generation capacity, if any.	A5	NA
A6.	Enter the site population.		
	a. Military	A6a	NA
	b. Civilian	A6b	NA
A7.	Enter the facilities on the base.		
	a. Number	A7a	NA
	b. Total area (ft^2)	A7b	NA
A8.	Enter the buildings on the base.		
	a. Number	A8a	NA
	b. Total area (ft^2)	A8b	NA
A9.	Enter the housing units on the base.		
	a. Number of single-family units	A9a	NA
	b. Number of multiple-family units	A9b	NA
	c. Total area (ft^2)	A9c	NA
A10.	Fill in Table A-1 with the monthly demand and consumption data obtained from the utility bills.	A10	Table A-1
A11.	Enter the peak demand; it is the highest value entered in the Demand column of Table A-1.	A11	15120 kW
A12.	Enter the peak demand month.	A12	SEPTEMBER
A13.	Enter the high month energy consumption; it is the highest value entered in the Energy column of Table A-1.	A13	8.568 $\times 10^6$ kwh
A14.	Enter the sum of the monthly peak demand values by adding the data in the Demand column of Table A-1.	A14	159139 kw
A15.	Enter the total annual energy consumption by adding the data in the Energy column of Table A-1.	A15	78 89 $\times 10^6$ kwh

WORKSHEET A (continued)

Table A-1. Demand and Consumption

Month	Demand (kW Peak)	Energy (kWh) (x10^6)
January	10013	5.129
February	10685	5.208
March	11491	4.995
April	12096	5.551
May	13574	6.260
June	14784	7.963
July	14784	7.772
August	14784	7.683
September	15120	8.568
October	15187	[illegible]
November	14122	[illegible]
[illegible]	2459	[illegible]
[illegible]	[illegible]	[illegible]

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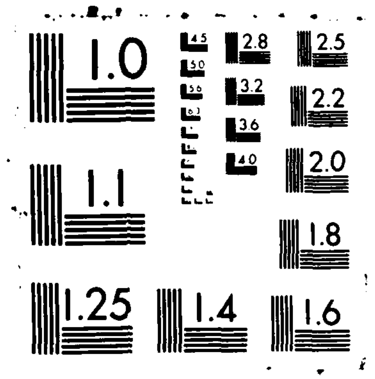
1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
5.0
5.6

WORKSHEET B

B1. Fill in the Demand column of Table B-1 using hourly load data for two average workdays and one normal weekend day obtained from the utility. If 15-minute interval data are provided, calculate the hourly average. Sum each of the three Demand columns and enter the total.	B1 Table B-1
B2. Calculate the average of the three Demand column totals from Table B-1.	B2 N.A.
B3. Calculate the percent of peak demand. For each hour's entry in the Demand column, divide by the highest value for that day in the same column and enter the result in the adjacent column, % of Peak.	B3 Table B-1
B4. Determine the three-hour period that best represents the late night, flat load level period, A. (Look in Table B-1 around the period from 0300 to 0600 for four entries that are about the same percent.)	B4 0300-0600
B5. Determine the three-hour period that best represents the day peak, flat load level period, B. (Look in Table B-1 around the period from 1200 to 1600 for four entries that are about the same percent.)	B5 1200-1600
B6. Determine the three-hour period that best represents the evening, flat load level period, C. (Look in Table B-1 around the period from 1900 to 2200 for four entries that are about the same percent.)	B6 1900-2200
B7. Determine the average percentage load for the A and C flat load periods for each day; the average percentage load period B is 100%. Fill in Table B-2.	B7 Table B-2
B8. Determine the month's average percentage load for the three flat load periods and enter in Table B-2. If these data are not available, use the following default values for the three flat load periods: A: Late night period 55% B: Day peak period 100% C: Evening period 85%	B8 Table B-2
B9. Plot the generic load profile onto Figure B-1 using the month's average data in Table B-2.	B9 Figure B-1

WORKSHEET B (continued)

Table B-1. Load Profile Hourly Data

	Weekday #1 Date: ________		Weekday #2 Date: ________		Weekend Day Date: ________	
Hour	Demand (kW)	% of Peak	Demand (kW)	% of Peak	Demand (kW)	% of Peak
0100						
0200						
0300						
0400						
0500						
0600						
0700		N.A. FOR THIS CASE				
0800						
0900	DEFAULT VALUES ARE USED					
1000						
1100						
1200						
1300						
1400						
1500						
1600						
1700						
1800						
1900						
2000						
2100						
2200						
2300						
2400						
Total		----		----		----

WORKSHEET B (continued)

Table B-2. Average Percentage Load for Flat Load Level Periods

Date	A: Late Night	B: Day Peak	C: Evening
Weekday #1	N.A.	100	N.A.
Weekday #2	N.A.	100	N.A.
Weekend day	N.A.	100	N.A.
Default Values	55	100	85
Month's Average	55	100	85

WORKSHEET B (Continued)

Total Area = DEFAULT VALUES
5% Area = USED.
10% Area = DO NOT HAVE
15% Area = TO CALCULATE.

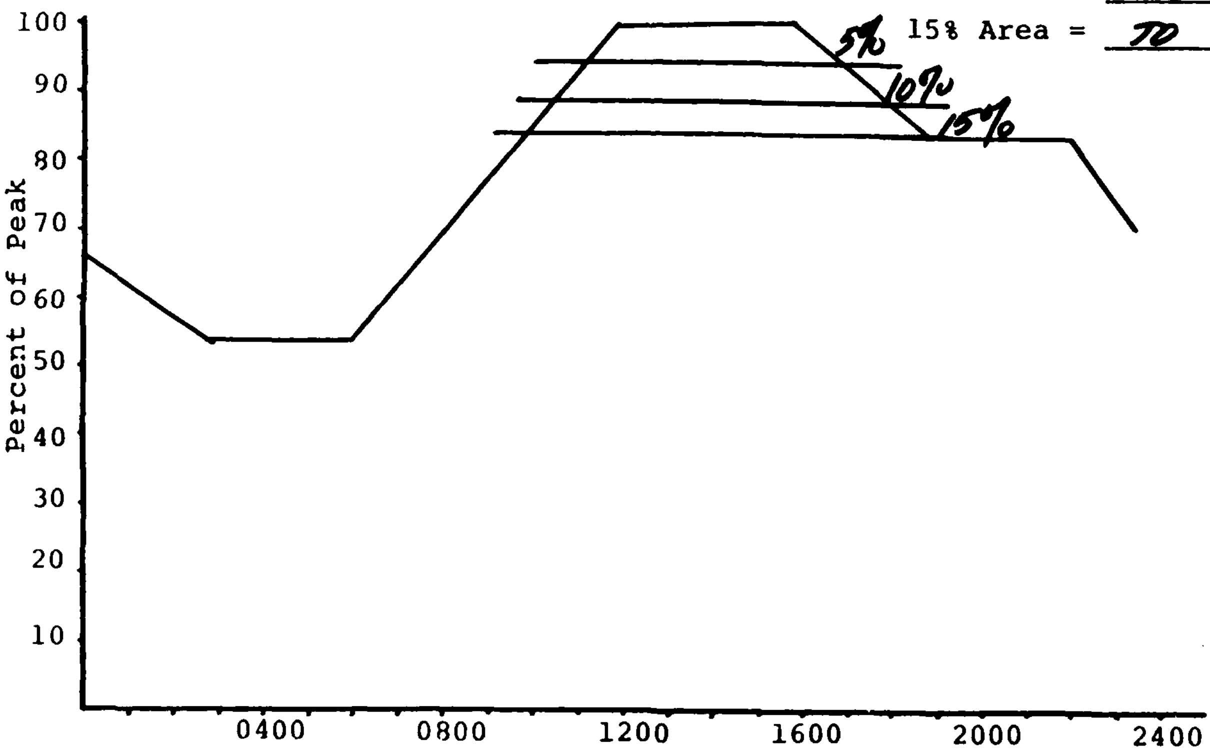

Figure B-1. Plot of the Generic Load Profile

END OF WORKSHEET B

WORKSHEET C

C1.	Enter the peak power demand in the three utility-defined periods in Table C-1. (Either use the utility bill as the source for these data or request the data from the utility.)	C1	Table C-1
C2.	Enter the demand charge rates ($/kW) for on-peak, mid-peak, and off-peak demand for the different kW ranges indicated in Table C-1.	C2	Table C-1
C3.	Enter the actual demand charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total demand charges. (Use the utility bill as the source for these data.)	C3	Table C-1
C4.	Enter the energy consumed in the three utility-defined periods in Table C-1. (Use the utility bill as the source for these data.)	C4	Table C-1
C5.	Enter the energy charge rates ($/kWh) for on-peak, mid-peak, and off-peak energy consumption or for the different kWh ranges indicated in Table C-1.	C5	Table C-1
C6.	Enter the actual energy charges for each level in the three utility-defined periods in Table C-1. Sum the three values to obtain the total energy charges. (Use the utility bill as the source for these data.)	C6	Table C-1
C7.	Enter the total for each entry in Table C-1 in the Total column.	C7	Table C-1
C8.	Enter the surcharges that are listed on the utility bill.		
	a. Fuel adjustment (0.0216 $/kWh)	C8a	$185068
	b. Customer charges	C8b	—
	c. Equipment rental	C8c	—
	d. R&D fund	C8d	—
	e. Other	C8e	—
	f. Total Surcharges (sum C8a through C8e)	C8f	$185068
C9.	Enter the credits that are listed on the utility bill.		
	a. Transformer	C9a	—
	b. Power factor adjustment	C9b	—
	c. Other	C9c	—
	d. Total Credits (sum C9a through C9c)	C9d	—

WORKSHEET C (continued)

C10. Enter the net additional charges. (C8f minus C9d) C10 $185068

C11. Enter the total actual payments (Total demand charges from Table C-1 + Total energy charges from Table C-1 + C10) C11 $376386

WORKSHEET C (continued)

Table C-1. Demand and Consumption Data

Utility Bill Entry	Time of Day: On-peak	Mid-peak	Off-peak	Total
Peak Power Demand (kW)	15120			-----
Demand Charge Rates ($/kW)				
0 to ______ kW	$6.25			-----
______ to ______ kW				-----
______ to ______ kW				-----
Demand Charges ($)				
0 to X kW				
X to Y kW				
Y to Z kW				
Total Demand Charges	$94500			$94500
Energy Consumed (kWh)	8580000			8580000
Energy Charge Rates ($/kWh)				
0 to ______ kWh	$0.0113			-----
______ to ______ kWh				-----
______ to ______ kWh				-----
Energy Charges ($)				
0 to X kWh				
X to Y kWh				
Y to Z kWh				
Total Energy Charges	$96818			$96818

END OF WORKSHEET C

WORKSHEET D

Basic Methodology

D1. Mark the 5%, 10%, and 15% peak shaving levels on the generic load profile curve, Figure B-1 of Worksheet B.

D1 Figure B-1

D2. Calculate the energy reduction factor, r, corresponding to the 5%, 10%, and 15% peak shaving levels. Divide the area that represents the 5%, 10%, and 15% reduction levels by the total area under the generic load profile curve.

a. 5% energy reduction factor
b. 10% energy reduction factor
c. 15% energy reduction factor

D2a 0.013
D2b 0.03
D2c 0.05

If the default generic load profile curve was used for Figure B-1, enter the default values as follows:

for 5% reduction, r = 0.013
for 10% reduction, r = 0.03
for 15% reduction, r = 0.05

D3. Calculate the energy reduction for the month under analysis for each level of peak shaving.

a. for 5%, D2a x A13
b. for 10%, D2b x A13
c. for 15%, D2c x A13

D3a 111384 kWh
D3b 257040 kWh
D3c 428400 kWh

D4. Calculate the dollar savings due to the reduction of energy consumption. Use the highest C5 entry from Worksheet C, which is the energy rate in $/kWh. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1.

a. for 5%, D3a x C5
b. for 10%, D3b x C5
c. for 15%, D3c x C5

D4 Table D-1

D5. Calculate the peak demand reduction for the 5%, 10%, and 15% reduction levels.

a. for 5%, A11 x 0.05
b. for 10%, A11 x 0.10
c. for 15%, A11 x 0.15

D5a 756 kW
D5b 1512 kW
D5c 2268 kW

D6. Calculate the dollar savings due to the reduction of peak demand. Use the highest C2 entry from Worksheet C, which is the demand rate in $/kW. Enter the dollar savings for the 5%, 10%, and 15% reduction levels in Table D-1.

a. for 5%, D5a x C2
b. for 10%, D5b x C2
c. for 15%, D5c x C2

D6 Table D-1

D7. Calculate the surcharge reduction, if applicable, and enter in Table D-1. For an energy-related surcharge (i.e, $/kWh), the dollar savings would be as follows: — D7 Table D-1
   a. for 5%, surcharge rate from C8 entry x D3a
   b. for 10%, surcharge rate from C8 entry x D3b
   c. for 15%, surcharge rate from C8 entry x D3c

   For a demand-related surcharge (i.e., $/kW), the dollar savings would be as follows:
   d. for 5%, surcharge rate from C8 entry x D5a
   e. for 10%, surcharge rate from C8 entry x D5b
   f. for 15%, surcharge rate from C8 entry x D5c

D8. Calculate the credit increase, if applicable, and enter in Table D-1. For an energy-related credit (i.e., $/kWh), the dollar savings would be as follows: — D8 Table D-1
   a. for 5%, credit rate from C9 entry x D3a
   b. for 10%, credit rate from C9 entry x D3b
   c. for 15%, credit rate from C9 entry x D3c

   For a demand-related credit (i.e., $/kW), the dollar savings would be as follows:
   a. for 5%, credit rate from C9 entry x D5a
   b. for 10%, credit rate from C9 entry x D5b
   c. for 15%, credit rate from C9 entry x D5c

D9. Determine the potential monthly dollar savings due to peak shaving by summing the data in Table D-1. — D9 Table D-1

Annual Savings - Approximate Method

This method will overstate the annual savings.

D10. To approximate the annual savings due to peak shaving, multiply the Monthly Dollar Savings by 12 in Table D-1. — D10 Table D-1

Annual Savings - Improved Method

D11. Do steps D3 through D8 of the basic methodology using A15 and A14 in place of A13 and A11, respectively.

Step D3:	D2a x A15	D11a 1024920 kWh
	D2b x A15	D11b 2365200 kWh
	D2c x A15	D11c 3942000 kWh
Step D4:	D11a x C5	D11d Table D-2
	D11b x C5	
	D11c x C5	

WORKSHEET D (continued)

Step D5:	A14 x 0.05 A14 x 0.10 A14 x 0.15	D11e D11f D11g	7957 kW 15914 kW 23871 kW
Step D6:	D11e x C2 D11f x C2 D11g x C2	D11h	Table D-2
Step D7:	D11a x C8 D11b x C8 D11c x C8	D11i	Table D-2
Step D8:	D11e x C9 D11f x C9 D11g x C9	D11j	Table D-2

D12. Determine the potential annual dollar savings due to peak shaving by summing the data in Table D-2. — D12 Table D-2

Annual Savings - More Accurate Method

This method produces the same results as the improved method when the energy and demand charge rates in entries C5 and C3 do not vary with the energy and demand levels.

D13. Do steps D3 through D8 of the basic methodology twelve (12) times, once for each month. Use each month's energy and demand data from Table A-1 in place of A13 and A11, respectively. Also use the appropriate energy and demand rate to match the energy and demand values for steps D4 and D6. Use Table D-3 to enter the results from each step. — D13 Table D-3

D14. Determine the potential annual dollar savings due to peak shaving. Fill in Table D-4 with the appropriate data from Table D-3 and sum. — D14 Table D-4

WORKSHEET D (continued)

Table D-1. Potential Annual Dollar Savings - Approximate Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings	1259	2905	4841
D6 Demand Dollar Savings	4725	9450	14175
D7 Surcharge Dollar Savings	2406	5552	9253
D8 Credit Dollar Increase	—	—	—
Monthly Dollar Savings (D4 + D6 + D7 - D8)	$8390	$17907	$28269
Annual Dollar Savings (Monthly Savings X 12)	$100,680	$214,884	$339,228

WORKSHEET D (continued)

Table D-2. Potential Annual Dollar Savings - Improved Method

Contribution to Dollar Savings	Percent Peak Shaving		
	5%	10%	15%
D4 Energy Dollar Savings	11582	26727	44545
D6 Demand Dollar Savings	49731	99462	149194
D7 Surcharge Dollar Savings	22138	51088	85147
D8 Credit Dollar Increase	—	—	—
Annual Dollar Savings (D4 + D6 + D7 - D8)	$83,451	$177,277	$278,886

WORKSHEET D (continued)

Table D-3. Basic Methodology Steps D3 through D8 Applied to More Accurate Method

Month	STEPS					
	D3	D4	D5	D6	D7	D8
Jan						
Feb						
Mar						
Apr		N.A. FOR THIS CASE				
May						
Jun						
Jul						
Aug						
Sep						
Oct						
Nov						
Dec						

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 5% Peak Shaving

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr		N.A. FOR THIS CASE			
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 10% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr		N.A. FOR THIS CASE			
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

WORKSHEET D (continued)

Table D-4. Annual Savings from More Accurate Method for 15% Peak Shaving (continued)

Month	Energy Savings (D4)	Demand Savings (D6)	Surcharge Savings (D7)	Credit Increases (D8)	Total Monthly Savings (D4 + D6 + D7 -D8)
Jan					
Feb					
Mar					
Apr		N.A. FOR THIS CASE			
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
Total Annual Savings					

END OF WORKSHEET D

WORKSHEET E

E1. Enter the DOE Region number for the base location. — E1 4 TABLE B-4a

E2. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 10 years	E2a	7.03
b. 15 years	E2b	9.03
c. 20 years	E2c	10.41
d. 25 years	E2d	11.37

E3. Enter the present value (PV) of the 5%, 10%, and 15% savings for system lifetimes of 10, 15, 20, and 25 years in Table E-1. — E3 Table E-1

PV = E2 (UPW factor for 10, 15, 20, and 25 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E4. Enter the estimated total project cost for the different alternatives (calculated in E3) in Table E-2. Assume SIR values of 1, 3, and 5. — E4 Table E-2

Project cost = E3 entry ÷ SIR

(This equation is approximate only and assumes the ratio of maintenance cost to investment cost is low.)

E5. Enter the UPW Discount Factor Adjusted for Average Fuel Price Escalation for industrial electricity and a 7% discount rate (use Ref. 4).

a. 3 years	E5a	2.64
b. 4 years	E5b	3.42
c. 5 years	E5c	4.14
d. 6 years	E5d	4.81

E6. Enter the total project cost for assumed DPB values of 3, 4, 5, and 6 years in Table E-3. — E6 Table E-3

Project cost = E5 (UPW factor for 3, 4, 5, and 6 years) x Annual Savings from Worksheet D (either D10, D12, or D18 depending on which method was used).

E7. Enter the estimated cost range for a peak shaving project based on achieving an SIR = 5 or a DPB = 6 years.

a. 5% peak shaving	E7a	$120K-400K
b. 10% peak shaving	E7b	$250K-850K
c. 15% peak shaving	E7c	$392K-1,340K

WORKSHEET E (continued)

E8. Enter the expected cost of the alternative peak shaving techniques.

a. Interconnection — E8a $25K*
b. EMCS — E8b $800K**
c. On-site power generation — E8c $1.9M for 5%; $4.2M for 10%; $6.7M for 15% ***

E9. The results from E4 and E6 overlap to illustrate the relationship between the SIR and the DPB. A comparison of E7 with E8 is the basis for pursuing further analysis. An E8 value that is considerably greater than the range of values in E7 is not an economically viable project.

* ONE MILE DISTANCE.

** DEDICATED HARD-WIRED SYSTEM; 800 STATIONS.

*** DIESEL SYSTEM; HEAT CREDIT NOT INCLUDED.

E9 CONCLUSION FOR THIS CASE

INTERCONNECTION - POTENTIALLY VIABLE TECHNIQUE; FURTHER STUDY SHOULD BE PURSUED.

EMCS - POTENTIALLY VIABLE TECHNIQUE IF 10-15% PEAK SHAVING CAN BE ACHIEVED; FURTHER STUDY SHOULD BE PURSUED.

ON-SITE GENERATION - EXPECTED COST SIGNIFICANTLY GREATER THAN ESTIMATED COST RANGE; MOST LIKELY NOT A VIABLE TECHNIQUE.

WORKSHEET E (Continued)

Table E-1. Present Value of Annual Savings

% Peak Shaving	System Lifetime			
	10 years	15 years	20 years	25 years
5	586,661	753,563	868,725	948,838
10	1,246,257	1,600,811	1,845,454	2,015,640
15	1,960,569	2,518,341	2,903,203	3,170,934

Table E-2. Estimated Total Project Cost for SIR = 1, 3, and 5.

	% Peak Shaving	System Lifetime			
		10 years	15 years	20 years	25 years
SIR = 1	5	586,661	753,563	868,725	948,838
	10	1,246,257	1,600,811	1,845,454	2,015,640
	15	1,960,569	2,518,341	2,903,203	3,170,934
SIR = 3	5	195,554	251,188	289,575	316,279
	10	415,419	533,604	615,151	671,880
	15	653,523	839,447	967,734	1,056,978
SIR = 5	5	117,332	150,713	173,745	189,768
	10	249,251	320,162	369,091	403,128
	15	392,114	503,668	580,641	634,187

WORKSHEET E (continued)

Table E-3. Estimated Total Project Cost for DPB = 3, 4, 5, and 6 years

% Peak Shaving	Discounted Payback Period			
	3 years	4 years	5 years	6 years
5	220,311	285.902	345,487	401,399
10	468,011	606,287	733,927	852,702
15	736,259	953,790	1,154,588	1,341,442

END OF WORKSHEET E

APPENDIX D

GLOSSARY OF TERMINOLOGY

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GLOSSARY OF TERMINOLOGY

Average monthly peak	The average of daily peaks for the month.
Cogeneration	The simultaneous generation of usable thermal energy and electrical energy from a single source.
Daily average	The average of the hourly peaks for the day.
Daily energy consumption	The integrated load for a 24-hour period, generally determined from reading a kilowatt-hour meter.
Daily peak	The maximum amount of power demanded during a 24-hour period.
Demand	The rate at which power is received, usually expressed in kW. Also referred to as "load."
Demand charges	An amount charged by the utility that is proportional to the value of the peak demand. Expressed in $/kW, demand charge policy is set by the utility.
Discounted payback period (DPB)	The time required for the cumulative savings from a capital investment to offset, or "payback," the initial investment cost plus cumulative future costs, taking into account the timing of the cash flows.
Energy	The integrated load or demand over a period of time, generally expressed in kWh.
Energy charges	An amount ($/kWh) charged by the utility that is proportional to the energy consumption during the billing period.
Energy consumption	The amount of electric energy used over a period of time, generally expressed in kilowatt-hours (kWh).
Energy management and control system (EMCS)	Integrated, computer-based information system and control equipment that accomplish energy savings for heating, ventilating, air conditioning, process equipment, lighting, chillers, and boilers.

Load	The amount of power demanded from the utility, generally expressed in kilowatts (kW).
Load profile	The variation by time of occurrence in the power demanded.
Load shedding	A demand reduction technique applied during high peak periods. Non-critical energy usage temporarily turned off or lowered.
Master meter	A single device that measures and indicates energy use of an installation or a major portion of an installation, such as the housing area.
Mid-peak period	The period of time during which total demand from a utility is between the on-peak demand and the off-peak demand. Also referred to as "partial peak" or "shoulder peak" by some utilities.
Monthly energy consumption	The integrated load for a month.
Monthly peak	The maximum amount of power demanded during a month.
Off-peak period	The period of time during which total demand from a utility is relatively low.
On-peak period	The period of time during which total demand from a utility is relatively high.
On-site generation	The generation of electrical power on-site by the customer and not purchased from the utility company.
Peak power	The maximum amount of power demanded during a specific time period. Also referred to as "peak load" or "peak demand."
Peak shaving	The process of reducing the peak power level demanded.
Power	The time rate of using electric energy, usually expressed in kW.

Power factor	A factor indicating the ratio of real power to the apparent power demanded from the utility.
Radio control system (RCS)	A system that monitors the electrical demand and automatically cycles electrical equipment using radio signals to reduce the demand under predetermined conditions.
Savings-to-investment ratio (SIR)	A numerical ratio calculated with the reduction in energy costs, net of increased non-fuel operation and maintenance costs, as the numerator, and the increase in investment costs, minus increased salvage values plus increased replacement costs, as the denominator. An SIR greater than one indicates the investment is cost-effective.
Uniform present worth (UPW) factor	A factor for finding the present value of an annually recurring uniform amount.

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